THE

Railway Engineer,

AN ILLUSTRATED MONTHLY REVIEW

OF

THE CONSTRUCTION, MACHINERY, AND ADMINISTRATION OF RAILWAYS.

Edited by S RICHARDSON BLUNDSTONE, Wh. Sch., M.I.Mech.E., Assoc.I.N.A.

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ARTICLES MARKED THUS * ARE ILLUSTRATED. ARTICLES MARKED † ARE ABSTRACTS OF PATENTS, THE PATENTEE'S NAME BEING GIVEN IN PARENTHESIS.

Petrolite Lamps.

PETROLITE is a new system of burning carburetted air under incandescent mantles and which is being introduced to railway companies for station lighting and other purposes by Petrolite, Ltd., 106, York Road, Lambeth, S.E.

A Petrolite lamp giving 50 c.p. costs, we are told, only one fourth that of a lamp burning ordinary paraffin, and is equal to gas at 2*s.* per 1,000 cubic feet. The heat of the incandescent mantle draws a current of air through a porous block saturated with petrol. For domestic purposes Petrolite lamps appear to be quite safe, as should the lamp be overturned, violently or otherwise, the light goes out.

The drawings we publish show the construction of Petrolite lamps, which are an improved form of Prof. Notkin's lamp. Fig. 1 is a vertical section. The absorbent block *C* is composed of diatomic earth and plaster of Paris. It is annular in horizontal section, and is perforated with a number of small vertical holes, *c*, *c*. It fits loosely into a brass case or container B, which in turn drops into any ornamental stand or is suspended from the bottom of a lantern.

In the centre of the container are two brass tubes, one within the other, the outer one *i* being fixed, and which are shown in detail by figs. 2 and 3. At the top of the inner tube *g* is a gauze burner over which is suspended an ordinary incan-

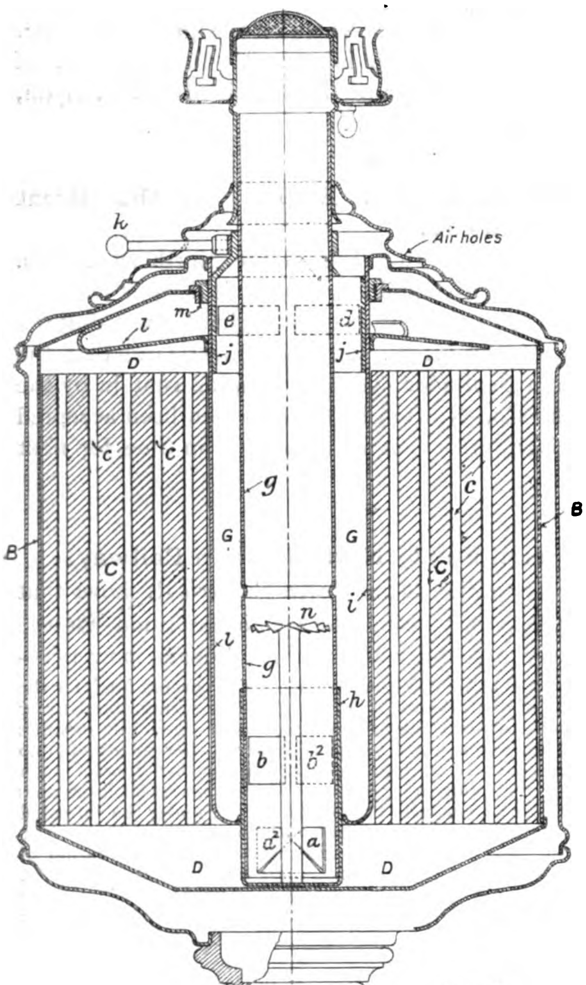
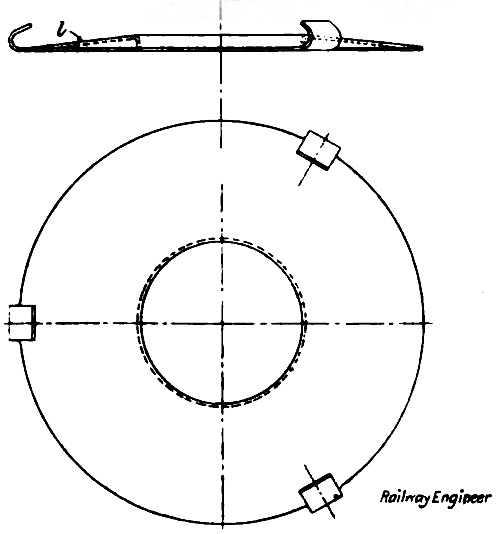


Fig. 1.



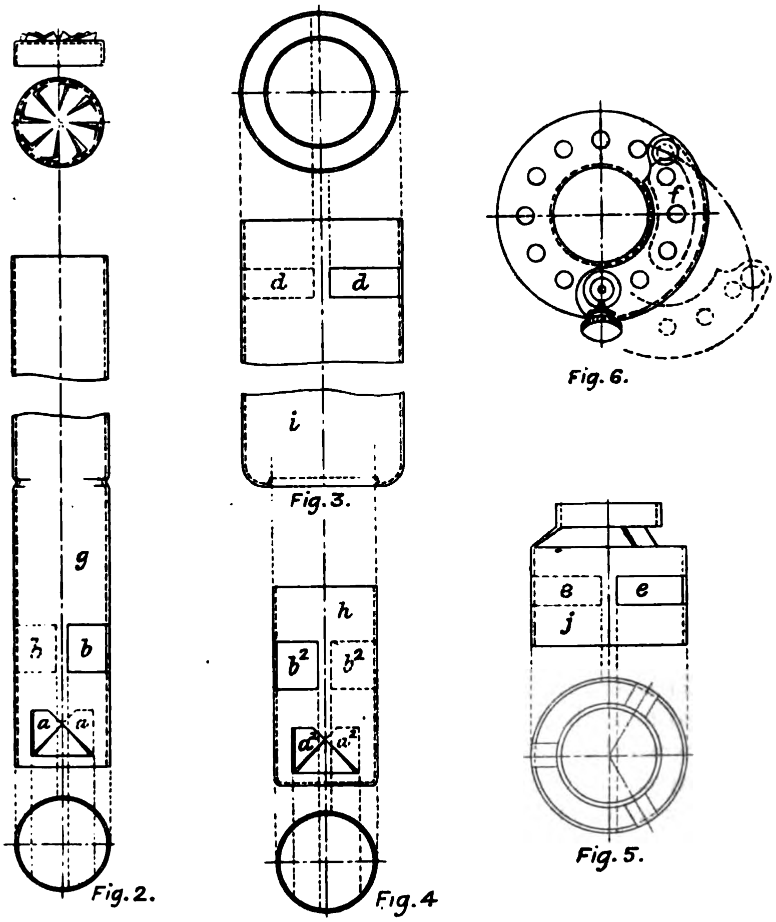
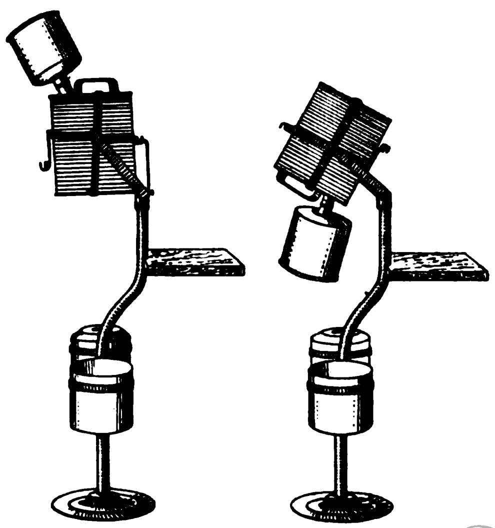


Fig. 2. Fig. 3. Fig. 4 Fig. 5. Fig. 6.



Continuous Brakes for Goods Trains.

THE necessity for providing our modern goods trains with continuous brakes was again demonstrated at Todmorden, L. and Y. R., on the 5th ultimo, when a goods train was smashed up, and the line blocked for nearly 24 hours, and the traffic of course disorganised, but fortunately no lives were lost.

This type of accident is now becoming rather frequent, and will, we fear, become more so in the near future. The train consisted of 70 wagons, drawn by two engines, it parted at about the 10th wagon, owing it is said to the failure of the coupling. The drivers discovered their train was divided, and kept ahead until their portion was stopped by signal. The rear portion on the falling gradient had got out of the guard's control and ran into the first part. A continuous brake would have prevented this accident. Another important point is, that the present wagon couplings, and particularly those of old private wagons, were not designed for the "double' trains now being worked, and they are constantly being strained, and very frequently give way. Hence this class of accident is as we said above, likely to be more frequent, until all the old couplings have been renewed.

*

York Railway Locomotive Works.

IN continuance of the North Eastern R. Co.'s policy of concentrating their locomotive repairing work at Darlington, the locomotive shops at York are, says the *Yorkshire Post*, in course of being closed. It was intimated recently in these columns that only one of the two erecting shops at York would for the future be used, and the company are now transferring the whole of the locomotive repairing department at York to Darlington. Much of the plant and machinery is also being transferred to the North Road works at Darlington. A proportion of the operatives now employed at the York locomotive works will be transferred to Darlington, but it is not probable that all the men will be so removed.

What is to be the future of the extensive shops and forges at York when the work is finally transferred to Darlington is not at present settled. Incidentally the change will give a little more accommodation in the old station yard, which is greatly needed, as it will liberate for the traffic department two or three sidings now utilised for shunting in the locomotive shops yard. The removal of the work to the larger shops at Darlington will, of course, secure a certain economy by reducing the cost of management and other expenses.

*

Walschaert Valve Gear.

WHEN noting the fact that one of the "Atlantic" express engines on the Great Northern R. has lately been fitted with the Walschaert valve gear, the *Iron and Coal Trades Gazette* remarks that the work is "unique," and that the gear "has not hitherto been adopted on any British-built railway engine." It would be difficult to say how many locomotives built in this country have been fitted with this gear, but our contemporary is apparently unaware that for several years there has been a good many engines on the Northern Counties R. in Ireland fitted with this gear, to say nothing of the steam motor carriages on the Great Western R., and other railways which have copied that design.

*

New Derbyshire Railway Scheme.

A Bill has been deposited in the Private Bills Office of the House of Commons for a new cross country railway through Derbyshire. The scheme is intended to provide a new connection with five of the great railways of the country starting at Hurdlow, eight miles out of Buxton, on the L. and North-Western R. The proposed line would run for 26 miles in a southerly course, taking in Matlock, Clay Cross, and Bolsover. This would give Matlock a competitive railway to the Midland, and the L. and North-Western R. its first entrance into the Derbyshire coal fields. At Heath and Bolsover the new route is intended to connect with the Great Central, Great Northern, Lancashire, Derbyshire, and East Coast, and Great Eastern lines. The cost of the project is estimated at about £500,000, and the scheme has received encouraging support from the owners on the proposed route. The engineer of the scheme is Mr. A. O. Ferguson, of Chesterfield, and the solicitor to the Bill is Mr. F. C. Lynn, the Town Clerk of Matlock Bath.

*

Four-Cylinder Compound Engine for the Great Northern Railway.

IT will be remembered that the Great Northern R. Co. invited British locomotive builders to submit designs for what they considered to be the best type of engine for working the express traffic of the G. N. R. We understand that the design for a large 4-cylinder compound engine sent in by the Vulcan Foundry Co., Newton-le-Willows, has been accepted and an order given for the engine to be built in time for next season's traffic.

*

Proposed Pension Fund; North Eastern Railway.

The Parliamentary notice of the North Eastern R. shows that the company proposes to establish a Pension Fund for the benefit of its servants, and asks for the following powers:—

To establish or provide for the establishment of a pension fund for the benefit of all or any of the servants of the Company, or of any Company or Joint Committee in which the Company are interested (including servants of the Fund to be established), and (subject as hereinafter mentioned) to authorise the Company to appropriate for the purposes thereof such moneys belonging to them and such proportion of the wages of such servants as they may think fit, or as may be provided for by or under the intended Act, and to invest, hold, or otherwise deal with the moneys set apart or accumulated for such fund and to authorise the making and alteration of rules for the management of the fund and otherwise in relation thereto, and to confer and impose upon the Company and upon any Committee that may be appointed and all parties concerned respectively such powers and obligations as are usual or convenient for the establishment and maintenance of such pension funds.

*

Railway Clearing Superannuation Fund Corporation.

THIS fund, which is commonly spoken of as the Clearing House Fund, and of which Lord Claud Hamilton is the Chairman of the Committee of Management, appears to be in anything but a satisfactory condition, as the actuaries, Messrs. Ralph P. Hardy & Geo. King, appointed to examine into its position, report a prospective deficiency of £482,937. There are over 400 annuitants on the fund. It has now 15,319 subscribers, whose subscriptions amount to £40,000 a year. Besides the members of the Clearing House Staff, those of the Great Central R., the South Eastern and Chatham, and about 40 smaller companies, which are not numerous enough to have their own fund, are members of the Clearing House Fund. The present annuitants are receiving 10% less than their proper pensions. A meeting of the contributors has been called for the 11th instant at the Drill Hall, Camden Town, N.W., to adopt the actuaries report.

Petrolite Lamps.

PETROLITE is a new system of burning carburetted air incandescent mantles and which is being introduced to companies for station lighting and other purpo Petrolite, Ltd., 106, York Road, Lambeth, S.E.

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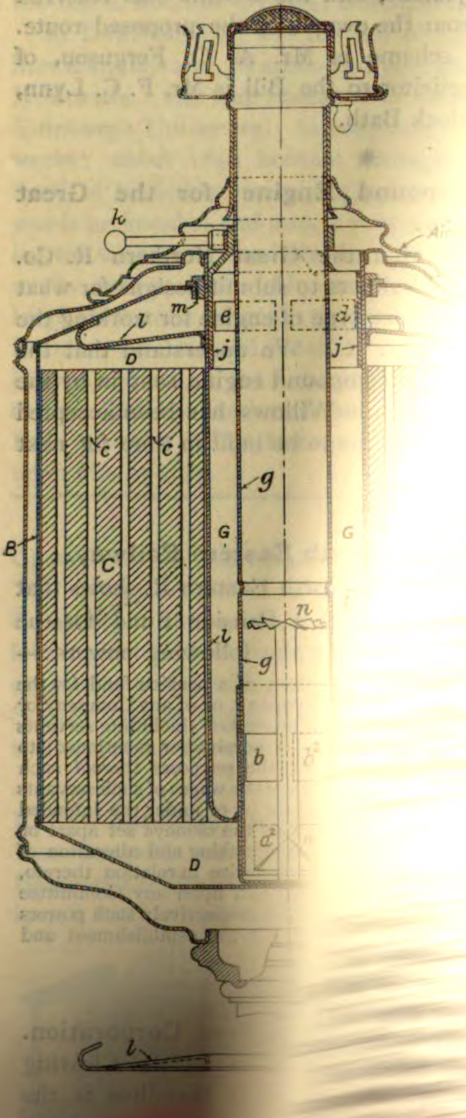


rched Ribs.—V.

luded from page 325.)

*atise on Arches,** 1897, page 20.

lic Arch, with two Hinges, one at each Support.

of Howe's *Treatise on Arches,** page 20, are given :—

$. (1 - 2k^2 + k^3)\}$ . . . . . (64)

. . . . (64a)

tion given in table I., page 316.

$k)$ . . . . (65)

$H_1 y - \sum^{x} P(x - a)$ . . . . . . (69)

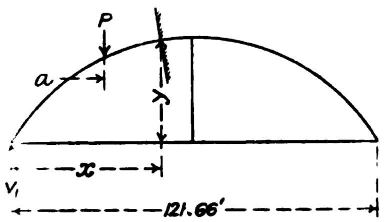


Fig. 19.

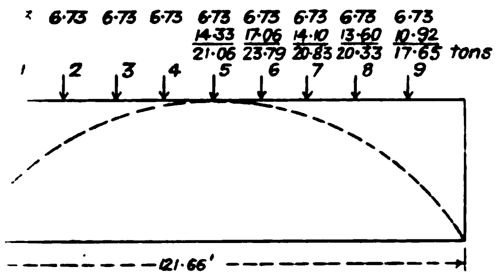


Fig. 20. Diagram of Loading.

$\sum^{l} P \Delta_1$

1 on fig. 20	=	6·73′ × ·0981	=	·6602 tons.
2	„	=	6·73 × ·1856	=	1·2490 „
3	„	=	6·73 × ·2541	=	1·7101 „
4	„	=	6·73 × ·2976	=	2·0028 „
5	„	=	21·06 × ·3125	=	6·5812 „
6	„	=	23·79 × ·2976	=	7·0799 „
7	„	=	20·83 × ·2541	=	5·2929 „
8	„	=	20·33 × ·1856	=	3·7732 „
9	„	=	17·65 × ·0981	=	1·7314 „
					30·0807 tons.

$$\text{Sum} = \tfrac{5}{8} \times \frac{121{\cdot}66'}{21{\cdot}88} \times 30{\cdot}0807 = 104{\cdot}54 \text{ tons.}$$

$$V_1 = \sum^{l} P(1 - k)$$

load 1 on fig. 20	=	6·73′ × ·9	=	6·057 tons.
2	„	=	6·73 × ·8	=	5·384 „
3	„	=	6·73 × ·7	=	4·711 „
4	„	=	6·73 × ·6	=	4·038 „
5	„	=	21·06 × ·5	=	10·530 „
6	„	=	23·79 × ·4	=	9·516 „
7	„	=	20·83 × ·3	=	6·249 „
8	„	=	20·33 × ·2	=	4·066 „
9	„	=	17·65 × ·1	=	1·765 „
					52·316 tons.

* Published by Wiley & Sons, New York.

$$M_x = V_1 x - H_1 y - \sum^{x} P(x - a)$$

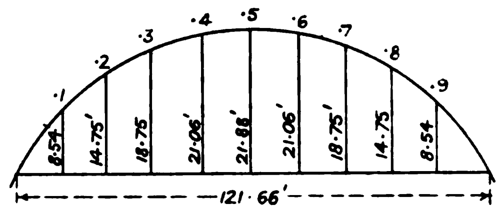


Fig. 21. Values of y.

Ft. Tons.

$$M_1 = 52{\cdot}316' \times 12{\cdot}16' - 104{\cdot}54' \times 8{\cdot}54' - 0$$
$$= 636{\cdot}16 - 892{\cdot}77 - 0 = -256{\cdot}61$$

$$M_2 = 52{\cdot}316' \times 24{\cdot}32' - 104{\cdot}54' \times 14{\cdot}75' - 6{\cdot}73' \times 12{\cdot}16'$$
$$= 1272{\cdot}32 - 1541{\cdot}96 - 81{\cdot}83 = -351{\cdot}47$$

$$M_3 = 52{\cdot}316' \times 36{\cdot}48' - 104{\cdot}54' \times 18{\cdot}75' - \left\{\begin{array}{l} 6{\cdot}73' \times 12{\cdot}16' \\ 6{\cdot}73' \times 24{\cdot}32' \end{array}\right\}$$
$$= 1908{\cdot}48 - 1960{\cdot}12 - 245{\cdot}51 = -297{\cdot}15$$

$$M_4 = 52{\cdot}316' \times 48{\cdot}64' - 104{\cdot}54' \times 21{\cdot}06' - \left\{\begin{array}{l} 6{\cdot}73 \times 12{\cdot}16 \\ 6{\cdot}73 \times 24{\cdot}32 \\ 6{\cdot}73 \times 36{\cdot}48 \end{array}\right\}$$
$$= 2544{\cdot}65 - 2201{\cdot}61 - 491{\cdot}02 = -147{\cdot}98$$

$$M_5 = 52{\cdot}316' \times 60{\cdot}80' - 104{\cdot}54' \times 21{\cdot}88' - \left\{\begin{array}{l} 6{\cdot}73 \times 12{\cdot}16 \\ 6{\cdot}73 \times 24{\cdot}32 \\ 6{\cdot}73 \times 36{\cdot}48 \\ 6{\cdot}73 \times 48{\cdot}64 \end{array}\right\}$$
$$= 3180{\cdot}81 - 2287{\cdot}33 - 818{\cdot}36 = +75{\cdot}12$$

$$M_6 = 52{\cdot}316' \times 72{\cdot}96' - 104{\cdot}54' \times 21{\cdot}06' - \left\{\begin{array}{l} 21{\cdot}06 \times 12{\cdot}16 \\ 6{\cdot}73 \times 24{\cdot}32 \\ 6{\cdot}73 \times 36{\cdot}48 \\ 6{\cdot}73 \times 48{\cdot}64 \\ 6{\cdot}73 \times 60{\cdot}88 \end{array}\right\}$$
$$= 3816{\cdot}97 - 2201{\cdot}61 - 1401{\cdot}80 = +213{\cdot}56$$

$$M_7 = 52{\cdot}316' \times 85{\cdot}12' - 104{\cdot}54' \times 18{\cdot}75' - \left\{\begin{array}{l} 23{\cdot}79 \times 12{\cdot}16 \\ 21{\cdot}06 \times 24{\cdot}32 \\ 6{\cdot}73 \times 36{\cdot}48 \\ 6{\cdot}73 \times 48{\cdot}64 \\ 6{\cdot}73 \times 60{\cdot}88 \\ 6{\cdot}73 \times 72{\cdot}96 \end{array}\right\}$$
$$= 4453{\cdot}14 - 1960{\cdot}12 - 2438{\cdot}20 = +54{\cdot}82$$

$$M_8 = 52{\cdot}316' \times 97{\cdot}28' - 104{\cdot}54' \times 14{\cdot}75' - \left\{\begin{array}{l} 20{\cdot}83 \times 12{\cdot}16 \\ 23{\cdot}79 \times 24{\cdot}32 \\ 21{\cdot}06 \times 36{\cdot}48 \\ 6{\cdot}73 \times 48{\cdot}64 \\ 6{\cdot}73 \times 60{\cdot}88 \\ 6{\cdot}73 \times 72{\cdot}96 \\ 6{\cdot}73 \times 85{\cdot}12 \end{array}\right\}$$
$$= 5089{\cdot}30 - 1541{\cdot}96 - 3400{\cdot}54 = +146{\cdot}80$$

$$M_9 = 52{\cdot}316' \times 109{\cdot}44' - 104{\cdot}54' \times 8{\cdot}54 - \left\{\begin{array}{l} 20{\cdot}33 \times 12{\cdot}16 \\ 20{\cdot}83 \times 24{\cdot}32 \\ 23{\cdot}79 \times 36{\cdot}48 \\ 21{\cdot}06 \times 48{\cdot}64 \\ 6{\cdot}73 \times 60{\cdot}88 \\ 6{\cdot}73 \times 72{\cdot}96 \\ 6{\cdot}73 \times 85{\cdot}12 \\ 6{\cdot}73 \times 97{\cdot}28 \end{array}\right\}$$
$$= 5725{\cdot}46 - 892{\cdot}77 - 4773{\cdot}75 = +58{\cdot}94$$

Bending moments from total load—

$$M_1 = -\ 256{\cdot}61 \text{ ft. tons.}$$
$$M_2 = -\ 351{\cdot}47 \text{ ,,}$$
$$M_3 = -\ 297{\cdot}15 \text{ ,,}$$
$$M_4 = -\ 147{\cdot}98 \text{ ,,}$$
$$M_5 = +\ 75{\cdot}12 \text{ ,,}$$
$$M_6 = +\ 213{\cdot}56 \text{ ,,}$$
$$M_7 = +\ 54{\cdot}82 \text{ ,,}$$
$$M_8 = +\ 146{\cdot}80 \text{ ,,}$$
$$M_9 = +\ 58{\cdot}94 \text{ ,,}$$
$$H_1 = 104{\cdot}54 \text{ tons.}$$
$$V_1 = 52{\cdot}316 \text{ ,,}$$

"*Symmetrical Parabolic Arch without Hinges.*"

The following formulæ are given on page 29 of Howe's *Treatise on Arches*, previously referred to:—

$$H_1 = \frac{15}{4n} \sum^{l} P\,k^2 (1-k)^2 \qquad (91)$$

$$= \frac{15}{4n} \sum^{l} P\,\Delta_{11} \qquad (91a)$$

Δ_{11} = function given in table XI. (page 321)

$$n = \frac{f}{l}$$

$$M_1 = \frac{l}{2} \sum^{l} P\,k\,(1-k)^2 (5\,k - 2) \qquad (92)$$

$$= \frac{l}{2} \sum^{l} P\,\Delta_6, \text{ reading } (1-k) \text{ for } k$$

$$M_2 = \frac{l}{2} \sum^{l} P\,\Delta_6$$

$$V_1 = \sum^{l} P\,(1-k)^2 (1+2k) \qquad (93)$$

$$= \sum^{l} P\,\Delta_7$$

$$y_1 = \frac{6}{5}\,\frac{5k-2}{9k}\,f$$

$$= f\,\Delta_8 \qquad (95)$$

$$y_2 = \frac{6}{5}\,\frac{3-5k}{9\,(1-k)}\,f$$

$$= f\,\Delta_8, \text{ reading } (1-k) \text{ for } k \qquad (96)$$

$$M_x = M_1 + V_1\,x - H_1\,y - \sum^{x} P\,(x-a) \qquad (100)$$

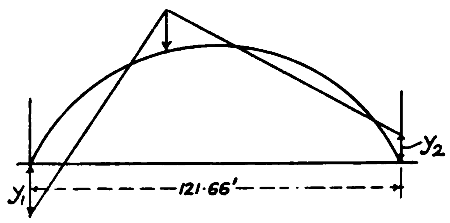


Fig. 22.

M_1 = moment at left support.
M_x = moment at any section x.

Diagram of loading same as fig. 20.

$$H_1 = \frac{15}{4n} \sum^{l} P\,\Delta_{11}.$$

		Tons.				Tons.
From load 1 on fig. 20	=	6·73	×	·0081	=	·0545
2 ,,	=	6·73	×	·0256	=	·1723
3 ,,	=	6·73	×	·0441	=	·2968
4 ,,	=	6·73	×	·0576	=	·3876
5 ,,	=	21·06	×	·0625	=	1·3162
6 ,,	=	23·79	×	·0576	=	1·3703
7 ,,	=	20·83	×	·0441	=	·9186
8 ,,	=	20·33	×	·0256	=	·5204
9 ,,	=	17.65	×	.0081	=	·1429
						5·1796

$$\text{Sum} = \frac{15}{4} \times \frac{121{\cdot}66}{21{\cdot}88} \times 5{\cdot}1796 = \underline{108{\cdot}00 \text{ tons.}}$$

$$M_1 = \frac{l}{2} \sum^{l} P\,\Delta_6 \text{ reading } (1-k) \text{ for } k.$$

		Tons.				Tons.
From load 1 on fig. 20	=	6·73	×	− ·1215	=	− ·8177
2 ,,	=	6·73	×	− ·1280	=	− ·8614
3 ,,	=	6·73	×	− ·0735	=	− ·4946
4 ,,	=	6·73	×	− ·0000	=	−
5 ,,	=	21·06	×	+ ·0625	=	+ 1·3162
6 ,,	=	23·79	×	+ ·0960	=	+ 2·2838
7 ,,	=	20·83	×	+ ·0945	=	+ 1·9684
8 ,,	=	20·33	×	+ ·0640	=	+ 1·3011
9 ,,	=	17·65	×	+ ·0225	=	+ ·3971
					Tons.	+ 5·0929

$$\text{Sum} = 60{\cdot}83^1 \times 5{\cdot}0929 = + \underline{309{\cdot}80 \text{ ft. tons.}}$$

$$M_2 = \frac{l}{2} \sum^{l} P\,\Delta_6$$

		Tons.				Tons.
From load 1 on fig. 20	=	6·73	×	+ ·0225	=	+ ·1514
2 ,,	=	6·73	×	+ ·0640	=	+ ·4307
3 ,,	=	6·73	×	+ ·0945	=	+ ·6359
4 ,,	=	6·73	×	+ ·0960	=	+ ·6461
5 ,,	=	21·06	×	+ ·0625	=	+ 1·3162
6 ,,	=	23·79	×	·0000	=	
7 ,,	=	20·83	×	− ·0735	=	− 1·5310
8 ,,	=	20·33	×	− ·1280	=	− 2·6022
9 ,,	=	17·65	×	− ·1215	=	− 2·1444

$$\text{Sum} + 60{\cdot}83 \times -\ 3{\cdot}0973 = -\ \underline{188{\cdot}41 \text{ ft. tons.}}$$

$$V_1 = \sum^{l} P\,\Delta_7$$

		Tons.				Tons.
From load 1 on fig. 20	=	6·73	×	·9720	=	6·5415
2 ,,	=	6·73	×	·8960	=	6·0301
3 ,,	=	6·73	×	·7840	=	5·2763
4 ,,	=	6·37	×	·6480	=	4·3610
5 ,,	=	21·06	×	·5000	=	10·5300
6 ,,	=	23·79	×	·3520	=	8·3741
7 ,,	=	20·83	×	·2160	=	4·4993
8 ,,	=	20·33	×	·1040	=	2·1143
9 ,,	=	17·65	×	·0280	=	·4942
					Sum	48·2208

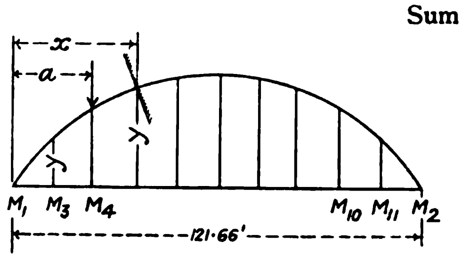


Fig. 23.

$$M\,x = M_1 + V_1\,x - H_1\,y - \sum^{x} P\,(x-a)$$

Ft. Tons.

$$M_3 = +\ 309{\cdot}80 + 48{\cdot}22\,(12{\cdot}16) - 108\ (8{\cdot}54) - 0$$
$$= 309{\cdot}80 + 586{\cdot}35 - 922{\cdot}32 = -\ \underline{26{\cdot}17}$$
$$M_4 = 309{\cdot}80 + 48{\cdot}22\,(24{\cdot}32) - 108\ (14{\cdot}75) - 6{\cdot}73^t\,(12{\cdot}16)$$
$$= 309{\cdot}80 + 1172{\cdot}21 - 1593 - 81{\cdot}83 = -\ \underline{192{\cdot}32}$$
$$M_5 = 309{\cdot}80 + 48{\cdot}22\,(36{\cdot}48) - 108\ (18{\cdot}75) - \left\{ \begin{matrix} 6{\cdot}73^t\,(12{\cdot}16) \\ 6{\cdot}73^t\,(24{\cdot}32) \end{matrix} \right\}$$
$$= 309{\cdot}80 + 1759{\cdot}06 - 2025 - 245{\cdot}51 = -\ \underline{201{\cdot}65}$$

Ft. tons.

$$M_6 = 309{\cdot}80 + 48{\cdot}22\,(48{\cdot}64) - 108\,(21{\cdot}06) - \left\{\begin{matrix} 6{\cdot}73\,(12{\cdot}16) \\ 6{\cdot}73\,(24{\cdot}32) \\ 6{\cdot}73\,(36{\cdot}48) \end{matrix}\right\}$$

$$= 309{\cdot}80 + 2345{\cdot}42 = 2274{\cdot}48 - 491{\cdot}02 = -\underline{110{\cdot}28}$$

$$M_7 = 309{\cdot}80 + 48{\cdot}22\,(60{\cdot}80) - 108\,(21{\cdot}88) - \left\{\begin{matrix} 6{\cdot}73\,(12{\cdot}16) \\ 6{\cdot}73\,(24{\cdot}32) \\ 6{\cdot}73\,(36{\cdot}48) \\ 6{\cdot}73\,(48{\cdot}64) \end{matrix}\right\}$$

$$= 309{\cdot}80 + 2931{\cdot}77 - 2363{\cdot}04 - 818{\cdot}36 = +\underline{60{\cdot}17}$$

$$M_8 = 309{\cdot}80 + 48{\cdot}22\,(72{\cdot}96) - 108\,(21{\cdot}06) - \left\{\begin{matrix} 21{\cdot}06 & (12{\cdot}16) \\ 6{\cdot}73 & (24{\cdot}32) \\ 6{\cdot}73 & (36{\cdot}48) \\ 6{\cdot}73 & (48{\cdot}64) \\ 6{\cdot}73 & (60{\cdot}88) \end{matrix}\right\}$$

$$= 309{\cdot}80 + 3518{\cdot}13 - 2274{\cdot}48 - 1401{\cdot}80 = \underline{+\,151{\cdot}65}$$

$$M_9 = 309{\cdot}80 + 48{\cdot}22\,(85{\cdot}12) - 108\,(18{\cdot}75) - \left\{\begin{matrix} 23{\cdot}79 & (12{\cdot}16) \\ 21{\cdot}06 & (24{\cdot}32) \\ 6{\cdot}73 & (36{\cdot}48) \\ 6{\cdot}73 & (48{\cdot}64) \\ 6{\cdot}73 & (60{\cdot}88) \\ 6{\cdot}73 & (72{\cdot}96) \end{matrix}\right\}$$

$$= 309{\cdot}80 + 4104{\cdot}48 - 2025 - 2438{\cdot}20 = \underline{-\,48{\cdot}92}$$

$$M_{10} = 309{\cdot}80 + 48{\cdot}22\,(97{\cdot}28) - 108\,(14{\cdot}75) - \left\{\begin{matrix} 20{\cdot}83 & (12{\cdot}16) \\ 23{\cdot}79 & (24{\cdot}32) \\ 21{\cdot}06 & (36{\cdot}48) \\ 6{\cdot}73 & (48{\cdot}64) \\ 6{\cdot}73 & (60{\cdot}88) \\ 6{\cdot}73 & (72{\cdot}96) \\ 6{\cdot}73 & (85{\cdot}12) \end{matrix}\right\}$$

$$= 309{\cdot}80 + 4690{\cdot}84 - 1593 - 3400{\cdot}54) = \underline{+\,7{\cdot}10}$$

$$M_{11} = 309{\cdot}80 + 48{\cdot}22\,(109{\cdot}44) - 108\,(8{\cdot}54) - \left\{\begin{matrix} 20{\cdot}33 & (12{\cdot}16) \\ 20{\cdot}83 & (24{\cdot}32) \\ 23{\cdot}79 & (36{\cdot}48) \\ 21{\cdot}06 & (48{\cdot}64) \\ 6{\cdot}73 & (60{\cdot}88) \\ 6{\cdot}73 & (72{\cdot}96) \\ 6{\cdot}73 & (85{\cdot}12) \\ 6{\cdot}73 & (97{\cdot}28) \end{matrix}\right\}$$

$$= 309{\cdot}80 + 5277{\cdot}17 - 922{\cdot}32 - 4773{\cdot}75 = \underline{-\,109.10}$$

Bending moments from total load—

$M_1 = +\ \underline{309{\cdot}80}$ ft. tons.
$M = -\ \underline{26{\cdot}17}$ „
$M_4 = -\ 192{\cdot}32$ „
$M_5 = -\ \underline{201{\cdot}65}$ „
$M_6 = -\ 110{\cdot}28$ „
$M_7 = +\ 60{\cdot}17$ „
$M_8 = +\ 151{\cdot}65$ „
$M_9 = -\ 48{\cdot}92$ „
$M_{10} = +\ 7{\cdot}10$ „
$M_{11} = -\ 109{\cdot}10$ „
$M_2 = -\ 188{\cdot}41$ „
$H_1 = 108{\cdot}00$ tons.
$V_1 = 48{\cdot}22$ „

Change of Temperature.

Howe's *Treatise on Arches* (pp. 29 and 36).

E = modulus of elasticity = 17,000,000 lbs.
θ = moment of inertia = 15491 ins.
e = co-efficient of expansion = ·0000067.
t° = degrees of change of temperature = 80° F.
$A = E\ \theta \cos.\ \phi$, if θ be taken at the crown $\cos.\ \phi = 1$ and $E\ \theta \cos.\ \phi$ is constant throughout.
f = rise of arch = 21·88 ft. = 262 ins.

Free Ends.

$$H_1 = \frac{15\ A}{8\ f^2}\ e\ t^\circ \qquad (86)$$

$$= \frac{15 \times 17{,}000{,}000 \times 15491 \times {\cdot}0000067 \times 80}{8 \times 262''}$$

$= 3855{\cdot}6$ lbs. $= 1{\cdot}72$ tons.

$$M = -\ H_1\ y \qquad (90)$$

Say at centre—

$- 1{\cdot}72' \times 21{\cdot}88' = 37{\cdot}63$ ft. tons.

Fixed Ends.

$$H_1 = \frac{45\ A}{4\ f^2}\ e\ t^\circ \qquad (140)$$

$$= \frac{45 \times 17{,}000{,}000 \times 15491 \times {\cdot}0000067 \times 80}{4 \times 262^2}$$

$= 23139$ lbs. $= 10{\cdot}33$ tons.

$$M_1 = M_2 = H_1\ \tfrac{2}{3}\ f \qquad (144)$$

$= 10{\cdot}33' \times \tfrac{2}{3}\ 21{\cdot}88'$
$= 150{\cdot}71$ ft. tons.

Uniform Loading.

Howe's *Treatise on Arches.*

Arch without hinges, p. 23.

$$H = \frac{1}{16\ n}\ w\ l\ \Big[_{k^{11}}^{k^{1}}\ k^2\,(5 - 5\ k^2 + 2\ k^3) \qquad (70)$$

$k = \tfrac{1}{2}$, $n = \dfrac{f}{l}$ and w = load per unit length of span,

$$= \frac{1}{16} \times \frac{121{\cdot}66}{21{\cdot}88} \times 121{\cdot}66 \Big[(\tfrac{1}{2})^2 \Big(5 - 5\,({\cdot}5)^2 + 2\,({\cdot}5)^3\Big)\ w$$

$$= \frac{121{\cdot}66^2}{16\,(21{\cdot}88)} \Big(\tfrac{1}{4}\,(+\,4)\Big)\ w$$

$= 42{\cdot}282\,(+\,1)\ w = +\ 42{\cdot}282\ w$
and $w = 1{\cdot}22$ (moving load)
$H_1 = 42{\cdot}282 \times 1{\cdot}22 = \underline{51{\cdot}58 \text{ tons.}}$

$$V_2 = \frac{w\ l}{2}\ \Big[_{k^{11}}^{k^{1}}\ k\,(2 - k) \qquad (71)$$

$$= \frac{121{\cdot}66}{2} \Big\{\tfrac{1}{2}\,(2 - \tfrac{1}{2})\Big\}\ w$$

$= 69{\cdot}83\,({\cdot}75)\ w = 45{\cdot}6225\ w$
and $45{\cdot}6225 \times 1{\cdot}22 = \underline{55{\cdot}66 \text{ tons}} = V_2$.

Arch with Fixed Ends. Howe's *Treatise on Arches*, pp. 37 and 175.

$$H_1 = \frac{w\ l}{8\ n}\ \Big[_{k^{11}}^{k^{1}}\ k^2\,(10 - 15\ k + 6\ k^2) \qquad (147)$$

$k = \tfrac{1}{2}$; $w = 1{\cdot}22$ tons

$$= \frac{121{\cdot}66}{8} \times \frac{121{\cdot}66}{21{\cdot}88} \Big\{(\tfrac{1}{2})^3\,[10\ \tfrac{15}{2} + \tfrac{6}{4}]\Big\}\ w$$

$$= \frac{121{\cdot}66^2}{8\,(21{\cdot}88)} \Big({\cdot}125\,(+\,4)\Big)\ w$$

$= 84{\cdot}564\,({\cdot}5)\ w = 42{\cdot}282\ w$
$= 42{\cdot}282\,(1{\cdot}22) = \underline{51{\cdot}58 \text{ tons.}}$

$$M_2 = \frac{w\, l^2}{2}\Big[k^2(-1 + 3k - 3k^2 + k^3)\Big]_{k''}^{k'} \quad . \quad . \quad . \quad (148)$$

$$= \frac{121{\cdot}66^2}{2}\Big[(\tfrac{1}{2})^2\Big(-1 + 3(\cdot5) - 3(\cdot5)^2 + (\cdot5)^3\Big)\Big]\, w$$

$$= \frac{121{\cdot}66^2}{2}(-\cdot03125)\, w$$

$$= -231{\cdot}267\, w = -231{\cdot}267\,(1{\cdot}22) = -\underline{282{\cdot}14 \text{ tons.}}$$

$$M_1 = \frac{w\, l^2}{2}\Big[k^2(1 - 2k + k^2)\Big]_{k''}^{k'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (149)$$

$$= \frac{121{\cdot}66^2}{2}\Big[(\tfrac{1}{2})^2\Big(1 - 2(\cdot5) + (\cdot5)^2\Big)\Big]\, w$$

$$= \frac{121{\cdot}66^2}{2}\Big((\tfrac{1}{2})^2(+\cdot25)\Big)\, w$$

$$= \frac{121{\cdot}66^2}{2}(+\cdot03125)\, w$$

$$= +231{\cdot}267\, w$$

$$= +231{\cdot}267\,(1{\cdot}22) = \underline{+284{\cdot}14 \text{ tons.}}$$

Dead Load Only $\cdot553$ tons $= w_0$

$$\frac{w_0\, l}{2} = \frac{\cdot553 \times 121{\cdot}66}{2} = 33{\cdot}64' = V_1$$

$$\frac{w_0\, l^2}{8\, k} = \frac{\cdot553 \times 121{\cdot}66^2}{8 \times 21{\cdot}88} = 46{\cdot}76' = H_1.$$

H_1 in both cases of free and fixed ends

Dead load $= 46{\cdot}76$
Moving load $= 51{\cdot}58$

$98{\cdot}34$ tons.

V_2 free ends $=$

Dead load $= 33{\cdot}64$
Moving load $= 55{\cdot}65$

$89{\cdot}29$

V_1 free ends $=$

Dead loads $= 33{\cdot}64$
Moving loads $= 18{\cdot}55 - (60{\cdot}83\,(1{\cdot}22) - 55{\cdot}66)$

$52{\cdot}19$

15-ton Covered Goods Wagon: Great Central Railway.

By the courtesy of Mr. J. G. Robinson, M.Inst.C.E., we are able to illustrate the 15-ton covered goods wagons which he has designed for the Great Central Railway. The economical advantages of high-capacity low-tare wagons have been so often pointed out and commented upon in these columns, that we need not now repeat them at length. Suffice it to say that a four-wheeled covered goods wagon of 15 tons capacity is probably in every way as economical as a bogie wagon of 50 tons capacity, and more so than one of 30 or 40 tons capacity.

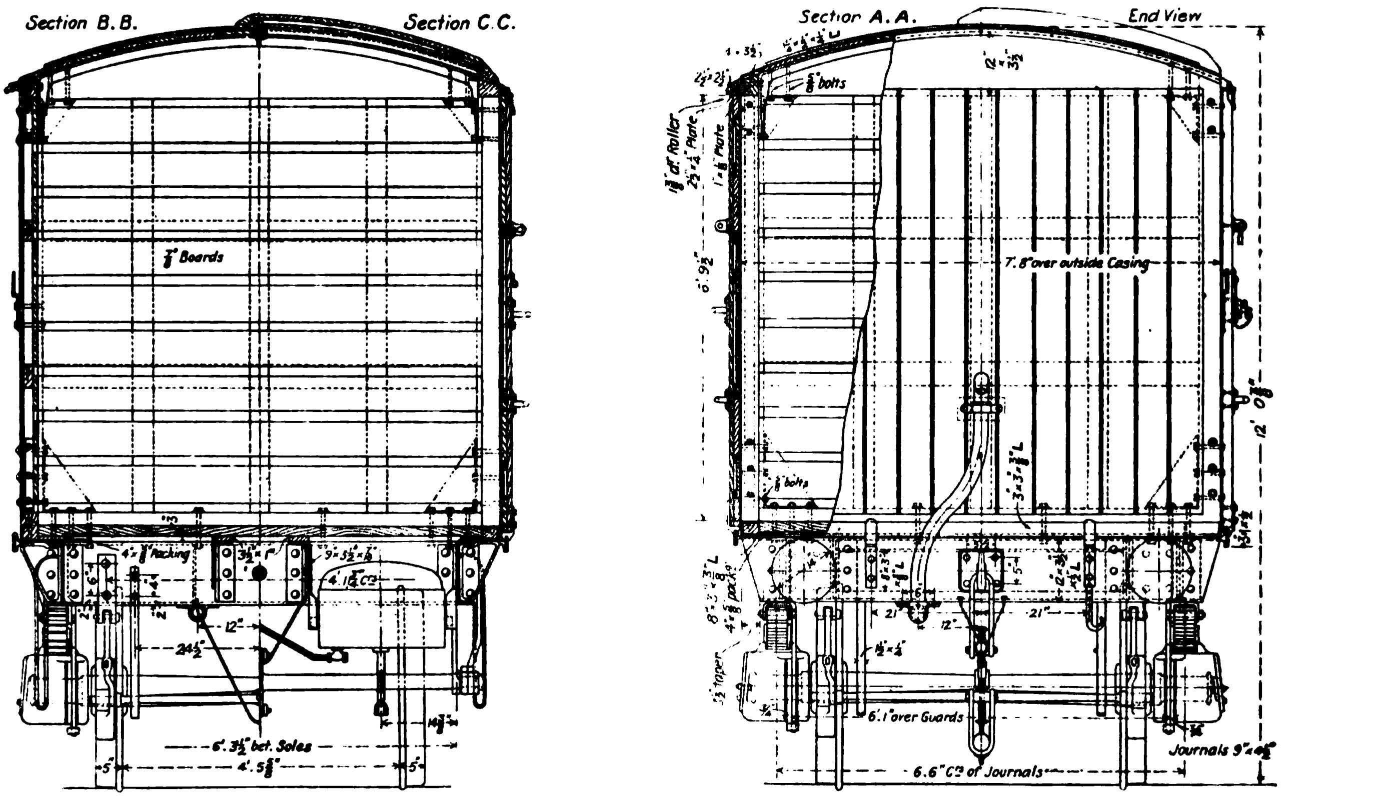
It will be seen, from the annexed drawings, that the body is constructed of wood, and the underfame of steel. The body framing is of oak, and the roof side-end and floor-boards of deal.

The dimensions and chief particulars are as under:—

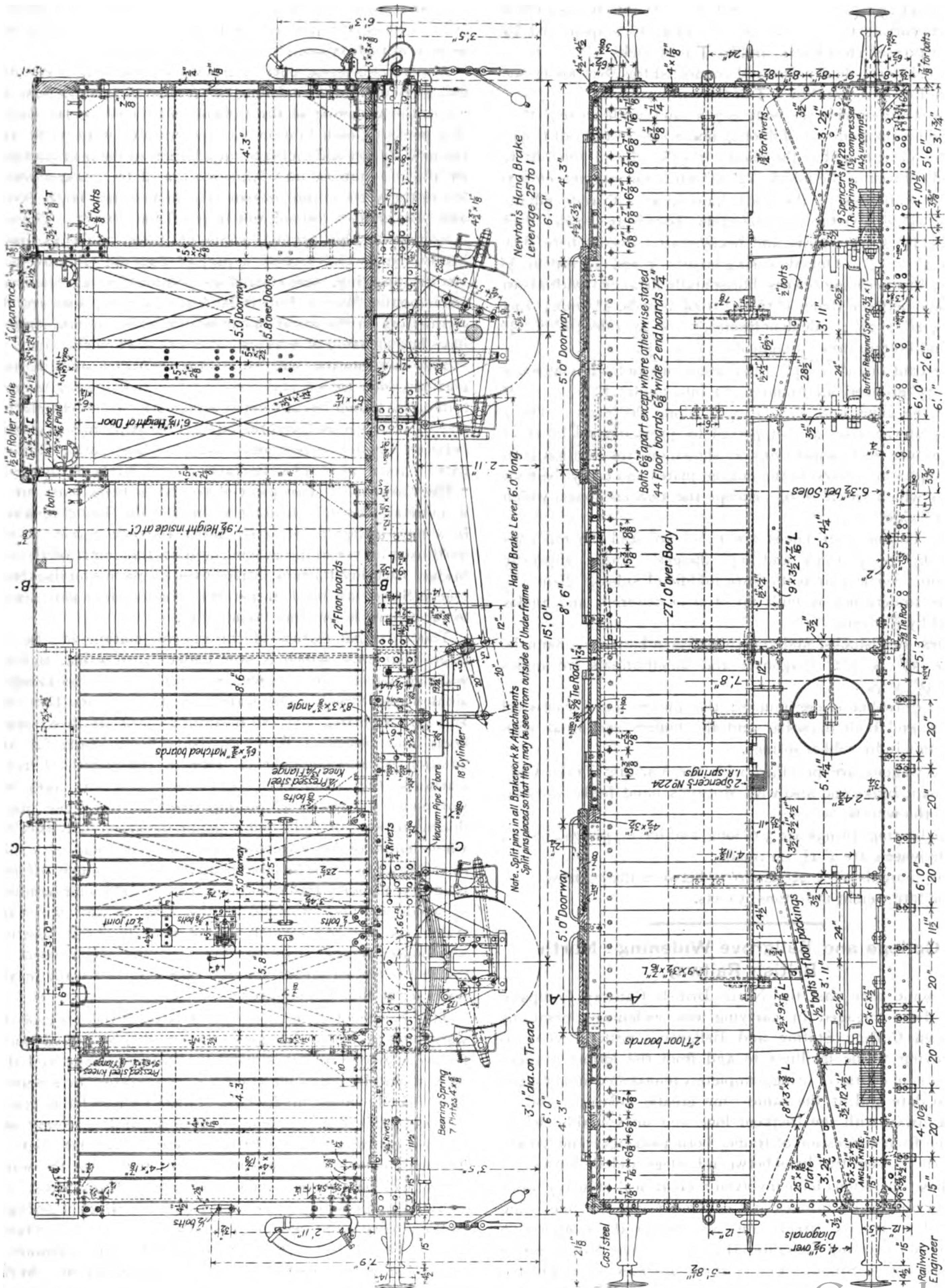
Length over buffers 30' 6¼"; length over headstocks and over body 27'; wheel base 15'; length inside 26' 5".

The wagon is fitted with two double sliding doors on each side, placed 13' 6" centre to centre. The doors are 5' 8" wide when closed, and give a clear opening 5' wide × 6' 11½" high.

There are also two roof doors diagonally over the side doors. These roof doors rest on rollers 1⅓" diam. × ½" wide, which roll on channel runners 1½" × ⅜" × ¼" on the outside of the roof, and give a clear opening right to the middle of the wagon. This greatly facilitates the loading or unloading of



Cross Sections and End View of 15-Ton Covered Goods Wagon, Great Central Railway.



15-Ton Covered Goods Wagon, Great Central Railway.

large packages (see cross section C C). The weakening effect of thus cutting the top rail of the sides is compensated by strong pressed steel knees, and by T roof sticks $3\frac{1}{2}'' \times 2'' \times \frac{3}{8}''$ bolted to the door posts, and connected together along the centre line of the roof by a T of the same section.

The width outside the body is 7' 8", and inside clear 7' 1".

The height from top of floor to under side of top rail 6' $9\frac{1}{2}''$, and the clear height in the middle 7' $9\frac{1}{4}''$. From the rail to outside of roof in the middle 12' $0\frac{5}{8}''$ when the wagon is empty.

The scantlings of the body framing are—Corner pillars, $4\frac{1}{2}'' \times 4\frac{1}{2}''$, grooved to take the casing boards as shown; door pillars, $4\frac{1}{2}'' \times 3\frac{1}{2}''$; posts and horizontals halved where they cross, $4'' \times 1\frac{7}{8}''$. Outside casing boards, T and G, vertical, $\frac{7}{8}''$ thick; inside casing boards, horizontally arranged with about 2" space between them, $\frac{7}{8}''$ thick; roof boards, $\frac{7}{8}''$ thick; roof sticks, $2\frac{1}{2}'' \times 2\frac{1}{2}''$; side door frames, $5'' \times 2\frac{1}{2}''$ sides; $6'' \times 1\frac{1}{4}''$ top and bottom rails; diagonals, $3\frac{1}{2}'' \times 1\frac{1}{4}''$.

The cant rail $4'' \times 3\frac{1}{2}''$; the bottom end and side plates are $4'' \times 3\frac{1}{2}''$ grooved all round to fit into angles $8'' \times 3'' \times \frac{5}{8}''$ along the sides and $3'' \times 3'' \times \frac{3}{8}''$ along the ends. These angles at the sides are supported by pressed steel brackets riveted into the channel soles, as shown on cross section B B. The angles are bolted to the bottom plates and carry the floor boards which are $2'' \times 6\frac{5}{8}''$, except the two end ones, which are $7\frac{1}{4}''$ wide.

The bottom post knees are $14'' \times 10''$ and the top ones $9'' \times 6\frac{1}{4}'' \times \frac{1}{2}''$ thick and $1\frac{3}{4}''$ flanges. Bolts generally $\frac{5}{8}''$ diam.; vertical tie-bolts down middle of sides $\frac{5}{8}''$ diam.

The underframe is built up of steel channels and angles joined by $\frac{3}{4}''$ rivets.

Soles, headstocks, and transverse members are channels, $12'' \times 3\frac{1}{2}'' \times \frac{1}{2}''$; diagonals and longitudinals are angles $9'' \times 3\frac{1}{2}'' \times \frac{7}{16}''$.

The draw-bar is continuous; the buffers have cast-steel guides, and both draw-bar and the buffers are fitted with Spencer's India-rubber springs.

The wagons are provided with the Vacuum Brake Co.'s automatic brake and also with Morton's hand brake working on all the wheels.

The bearing springs are 3' 6" long, and have 7 plates $4'' \times \frac{5}{8}''$.

The wheels are 3' $1\frac{1}{2}''$ on tread.

The journals $9'' \times 4\frac{1}{2}''$ and 6' 6" between the centres.

The tare weight is 10 tons. 5 cwts.

College and Bellgrove Widening: North British Railway.

For some time past the North British Railway Company have been engaged in carrying out widening operations between College Station and Bellgrove, with a view to improving traffic facilities to and from the former station, which is in course of being completely remodelled and brought up to date and at the same time greatly enlarged, and so doing away with the frequent long and unavoidable delays arising from congestion of traffic, both passenger and goods, over the present two lines between College and Bellgrove.

These operations have involved a great deal of heavy work in retaining walls, bridges and covered ways, the line being carried under six streets and also under the Corporation Cattle Markets and Slaughter Houses between Moore Street and Bellgrove Street. These works are now all completed and the permanent way is being laid down, so that the company should soon begin to reap the benefit of that portion of the extensive improvement they are carrying out on this portion of their system.

A more interesting part of the work, however, lies in the enlargement and remodelling of College Goods Station, for which the widening of the railway is to serve as an outlet. The present Goods Station is to be entirely swept away and the new station will embrace, in addition to the area occupied by the old station, that large portion of the ground which lies to the north of the present station between High Street and Alexander's School and facing Duke Street. The old buildings on this ground, some of them in ways quite historic, and which formed a part of that old Glasgow now fast disappearing, were cleared away some time ago, and for some months Messrs. Robert McAlpine & Sons, who are the contractors for the works in connection with the new station, have had an army of workers busily engaged on the site.

The new station will be in two separate and distinct portions, one for general merchandise and one for mineral traffic, the former being located on the site of the old station and adjacent ground, and the latter on that portion of ground between Hunter Street and Barrack Street facing Gallowgate. known as "The Barracks," and lately occupied by "The Carnival." This piece of ground is being laid out as a mineral depôt, access for railway traffic being obtained by a new bridge constructed under Barrack Street, at the north east corner of the ground, and to the south of the old bridge, carrying Barrack Street over the passenger lines from Queen Street low level station, while convenient cart access to the ground is got from Gallowgate.

The principal feature of the general station will be the large warehouse which is now under construction, and the walls of which can be seen rising above the barricading along Duke Street. The warehouse is to be 500 feet long and 321 feet broad, and will meantime consist of three upper floors and basement floor, provision being made for the addition of another floor as soon as the growth of traffic warrants the extension. The rails will run into the warehouse on the level of the lowest of the three upper floors, 10 sets of rails being required, which will run the whole length of the warehouse, and not far short of a mile of railway track will be laid inside the building alone. Three roadways for lorry traffic and five loading tables for handling of goods will be provided on this floor to deal with the traffic, and any goods which are not to be removed from the warehouse at once can be raised to the upper floors or lowered to the basement through openings and traps in the floors for storage till required.

The basement floor is extended beyond the area of the warehouse proper to the east of the building by arched vaults for a distance of 50 yards under the station sidings, and this floor should be useful for bonded store purposes, or a portion of it may be fitted up for cold storage for perishable goods. Access to this floor is obtained by a separate gateway and inclined roadway off Duke Street close by Alexander's School. The main entrances to the station and rail floor of the warehouse will be two in number and are off High Street and situated immediately on either side of College Passenger Station offices, the one on the south side of the offices being new. To give access to the yard from the latter entrance, a bridge has been thrown across the passenger station. At the point where High Street and Duke Street join a fourth access

is being formed, and from this corner a cartway will rise to the level of the second of the upper floors and run along the building from west to east immediately inside the wall facing Duke Street, so that cart traffic to and from the stores on the upper floors can be conducted without encroaching on the valuable space on the rail floor. Goods on the uppermost of the two storage floors will be lowered to the lorries on the roadway below through trap-doors in the floor. The chief idea throughout has been to prevent congestion of the different sets of traffic, and it is hoped that this plan of having separate roadways for each set on different levels, and each roadway with its separate entrance, will meet the object in view.

As already mentioned goods will be raised to the upper floors from the rail floor through openings in the floors. These openings will each be of considerable area, being almost 40 feet long by 25 feet broad, and will in addition to serving as a means for raising and lowering goods to and from the upper floors, form openings for ventilating, and to some extent lighting from the roof the lower floors. The building will be made fire-resisting throughout.

One of the most important points in connection with a building of this class is the nature of the equipment for handling the goods and in this case all the machinery is to be worked electrically. A large number of overhead travelling cranes are to be introduced in place of the more usual jib cranes fixed on the floor level, with a view to economising floor space, though a few of the latter kind will be used in special cases. These travelling cranes will be distributed over all three upper floors, the basement floor being served by those on the rail floor. In addition there will be a number of hoists communicating with all the floors and the basement.

On the rail floor a feature will be the method of dealing with the railway wagons inside the warehouse. No engine will be allowed inside the building, but all the movements of the wagons will be conducted by means of electric capstans and traversers.

The rails will run into the warehouse in sets of two or three, one road in each case being a feeding road for bringing in empty wagons or removing full ones.

By means of a series of traversers installed between adjacent lines of rails, the empty wagons, after being pulled into the feeding road by the capstans, will be traversed across from that line to the adjacent lines alongside the loading tables, the wagons being thus brought as near as possible to the point at which they are required. In the case of removing wagons which have been emptied at the tables or have received their load, the operation will be reversed. This method minimises the interference with the work of loading or unloading other wagons, and greatly expedites the handling of the traffic.

For dealing with special heavy loads, a large Goliath travelling crane capable of lifting 30 tons is to be installed in the yard close by, and should prove extremely useful in handling this class of goods.

The work has been in progress now for some time, and though most of it has as yet been of the nature of foundations and does not make much show, considerable progress has been made, so far, by the contractors.

In addition to the works at College and forming part of the same extensive scheme, there has just been completed at Shettleston a marshalling yard for the accommodation and marshalling of the traffic arising from College, &c., and further, the widening of the line, which at present has only been carried out to Bellgrove, is to be immediately extended to Parkhead. As already pointed out, the saving effected in expeditious handling of traffic and quick dispatch and marshalling of the trains, as well as the avoidance of long and expensive delays to trains, should be a great benefit to the company, both financially and otherwise, and should lead to substantial development of the goods traffic of the company in this quarter, a development which the greatly increased accommodation and facilities of College Goods Station itself should enable the company to look forward to with equanimity.

All these works are being executed to designs prepared by, and under the supervision of Mr. James Bell, M.Inst.C.E., the chief engineer to the railway company, Mr. Charles J. Brown, Assoc.M.Inst.C.E., their assistant engineer for new works, being in direct charge.

South Australian Railways: 1903-4.

THE annual report of the Railways Commissioner, Mr. Alan G. Pendleton, upon the operation of the South Australian Government railways during the year ended 30th June, 1904, states that:—

The capital expenditure was increased by £116,931 (spent chiefly on additional rolling-stock and machinery for the Islington Workshops), and amounted to £13,517,727.

The results of the working, exclusive of the Palmerston and Pine Creek line, as compared with the previous year are as follows:—

	£		£
Revenue—			
Passengers—First class ...	85,569	+	2,793
,, Second class ...	210,438	+	11,548
Mails, parcels, &c.	71,600	+	11,229
Minerals	250,469	+	23,741
Grain	59,596	+	30,018
Wool	18,129	—	1,561
Goods other than above ...	361,093	+	5,927
Live stock	72,011	—	349
Miscellaneous	31,734	+	681
	£1,160,639	+	£84,027
Expenditure—			
Maintenance	164,066	+	24,769
Locomotive branch ...	343,487	+	26,270
Traffic, general, &c. ...	167,842	—	155
	£675,395	+	£50,884

It is pleasing to record increased receipts under each head, except wool and live stock, and in these the small falling off is readily accounted for by the late drought. The mineral traffic shows an increase, owing to the greater tonnage from Broken Hill, the output of minerals in South Australia having fallen off during the period under review. The tonnage of grain carried was double that of the preceding year, and greater than in any previous year since 1891, when it was exceeded by about 6,000 tons. The rolling-stock proved equal to requirements, little occasion being given for complaints of delay in transit. This was due in no small degree to insisting on the trucks being more nearly loaded to capacity, and on prompt discharge at station of destination.

The percentage of working expenses to revenue was 58·19, as compared with 58·01 in the previous year.

The train mileage was 3,739,088, a decrease of 31,263 compared with the preceding year, which, in view of the fact that £84,000 more was earned, is satisfactory; and, although the policy of restricting the train service in many places was here and there loudly condemned, it is quite certain the

general convenience of the travelling public was not seriously interfered with, and the interests of the State were better conserved.

The receipts per mile open were £668, compared with £620, and per train mile run 74·50*d*., as against 68·53*d*. in the previous year.

The working expenses per mile open were £389, as against £360, and, owing to less mileage run, per train mile 43·35*d*., compared with 39·75*d*.

The expenditure was increased by £50,884 in (*a*) repairing damage done by floods in the North; (*b*) the necessary relaying of parts of the permanent way and the securing of second-hand rails for the Glencoe line; (*c*) an exceptional outlay in improving the condition of engines, and a small recoup with a view of replacing worn out rolling-stock; and (*d*) the purchase of 13 locomotives boilers. The traffic expenses and general charges show a slight reduction.

During the year the tonnage carried in connection with the Barrier fields amounted to 532,331, being an increase of 40,620, and the total receipts from all traffic passing through Cockburn amounted to £362,663, being an increase of £23,322. For the first time during the past four years the tonnage of ore dispatched from the Barrier shows an increase, which, it is believed, will be maintained in the future.

For some time past consideration has been given to the desirability of increasing the size of the trucks used in the ore traffic from Broken Hill, and "although all renewals will be "arranged by the building of one large-capacity truck in lieu "of three or four small ones condemned, I am not yet "satisfied that the undoubted saving arising from the use of "the larger truck would be sufficient to justify a recommenda-"tion that several hundred small wagons should be discarded "and one-third or one-forth the number of large ones built. "Such a course would have been most unwise during the "past few years, while the tonnage from Broken Hill was "falling off, and even now, when what looks like a continued "movement in the other direction has set in, I question "whether the saving in working with the larger truck would "more than reach the amount of interest payable on the "capital outlay for the old vehicles rendered unremunerative "and the new in running."

As the result of heavy rains, good supplies of water have been impounded in the reservoirs. The supply of water throughout the system is good.

The consideration given to the question of electrifying the Glenelg and other lines in the suburban area, and the consequent uncertainty as to the alterations in the tracks which would follow such work, have necessarily occasioned delay in bringing up to standard condition the way and works of the first-mentioned lines. The policy of "patching" the existing roads, in order to keep them fit to safely carry even the small engines at present in use, has been pursued beyond the bounds of economy; and no time should be lost in deciding as to the future method of working these lines.

Whilst the cost of maintaining the way, works, and building of these railways compares favorable with that of similar lines through the States, further economy is possible, without impairing efficiency, by improving the means of transporting men and materials. Steps have, therefore, been taken towards the gradual introduction of motor inspection cars and tricycles, and the replacement of present trollies by vehicles of a handier character.

For the better accommodation of shipping at Port Broughton, the outer end of the jetty has been widened, and the T-head extended.

Rail motor coaches are being introduced on certain lines, where the normal coaching traffic is small. They are being used with marked economy in the old country.

The working of the Palmerston and Pine Creek Line shows a substantial improvement.

The revenue was £17,006, being an increase of £5,708 on the previous year's returns. The expenditure was £13,219, as against £12,812. The gross receipts per mile open were £117, and the expenses £91. The train mileage was 31,545.

Chelmsford Motor Omnibuses: Great Western Railway.

The Great Western R. Co. have quite lately put on a service of motor cars between Wolverhampton and Bridge North, a very popular resort to which there is much traffic from all parts of the Black Country, but to which the railway communication is very indirect.

The service at present consists of three buses in each direction between Wolverhampton (G. W. R.) station and Bridgenorth, about 18 miles, and 13 intermediate buses in each direction between Wolverhampton and Wightwick. The time allowed for the longer journey is 1¼ hours, and 25 mins. for the shorter one, the single and return fares being 2*s*. and 3*s*. 6*d*. and 6*d*. and 1*s*. respectively, but intermediate fares are picked up anywhere on the journey. Parcels and luggage are also carried. Through railway tickets are not issued on nor by these buses.

For this service the G. W. R. company have adopted "Chelmsford" motor buses operated by steam, whereas all their other road motor services are worked with petrol driven cars.

The builders of the "Chelmsford" buses are Messrs. Clarkson, Ltd., of Chelmsford, and to that firm we are indebted for the photograph and following specification of their standard chassis. Three cars have been supplied for the service. Each has a seating accommodation for 19 passengers, of which the two in the rear are reserved for "smokers," leaving the top clear for luggage.

The outside of the cars are painted the G. W. R. standard colours—chocolate and cream. The interior is upholstered with Buffalo leather, and the windows fitted with spring blinds. The side windows are made to drop down and ventilators are fitted all round. The rear end is closed with a sliding door. The two rear seats which are outside the door are not glazed round but are fitted with storm curtains. The front seat is protected with semi-circular sliding windows.

The fuel used is ordinary paraffin, which is consumed in a patent burner without smoke or smell, and this in itself is a great gain, as the offensive smell of the petrol exhaust always seems to pervade the interior of petrol driven buses. The price of the oil is given at less than 4*d*. per gallon, and the average consumption of it about one gallon every 3½ to 4 miles under ordinary condition.

Another feature of these buses is their silent running.

It is worth notice that a service of "Chelmsford" buses has been in operation at Torquay for more than a year, and have given every satisfaction. Another has also been working well in the Lake District, where it, when fully loaded, climbs the hills with ease. Other buses are also at work in Sussex.

The specification of the "Chelmsford" Chassis, and to which those of the G.W.R. omnibuses were built, is as follows:—

The Frame to be formed of mild steel rolled channel, bent at the corners, and riveted with transverse members for the support of the engines and other details of the machinery.

Axles to be of the best construction with case-hardened bearings; the boxes to be accurately machined out and bushed with bronze.

Boiler.—The shell of the boiler to be constructed of mild steel, each part being pressed out of the solid plate. The tubes to be of weldless solid drawn steel; to be expanded in the top and bottom plates, and in addition, beaded over so that each tube forms a stay. The boiler to be tested by hydraulic pressure to 700 lbs. per square inch, and by steam to 400 lbs. per square inch. To be fitted with twin safety valves to blow off at 350 lbs. Automatic regulator to control the burner. A gauge to be fitted to indicate the water level.

Superheater.—A steel superheating tube to be fixed close beneath the lower tube plate of the boiler.

Burner.—The latest and most improved form of "Clarkson" burner to be used, capable of burning any grade of paraffin oil, whether kerosine, rocklight, homelight, &c. To be fitted with patent express starter, which needs no spirit. To be automatically regulated by the steam pressure, and to be entirely self-contained, enclosed in a sheet steel burner box, lined with

nickel and asbestos. A charging cup and fan to be provided for the starter. The consumption of the burner to be tested up to 25 lbs. of oil per hour, at a pressure of 40 lbs.

Engine.—To have two cylinders, 4 ins. × 4 ins. horizontal, double acting high pressure; valves to be actuated by "Joy's" gear. Cylinder and piston rings to be of special hard close grain iron. Piston rods and cross heads to be forged solid of steel; bored guides. Solid ended and ribbed steel connecting rods, bushed with phosphor bronze. Crank shaft of forged steel, case hardened, bored hollow, to be made in halves, riveted together with steel driving wheel between. Enclosed in a cast aluminium case, with sheet metal panels made removable, the top panel to have a circular inspection hole, fitted with a quickly removable lid.

Differential Gear.—The engine to drive direct on to a bronze gear ring encircling the differential gear box; the sides of the box to be of cast steel; the differential gear to be of the spur type. All six wheels to be of phosphor bronze, cut out of the solid, and working on hollow steel pins. The differential shafts to be of steel, forged solid with the wheels on the inner ends, the outer ends to be coned and screwed and fitted with key for securing the chain sprockets. Each shaft to be carried on two hard steel bronze bearings, having large wearing surfaces, which are ground to fit. The two inner bearings to take all end thrust. The outer bearings to be fitted wlth an oil retainer. Each shaft to carry two eccentrics, which are keyed on and fixed longitudinally by distance tubes.

Lubrication (General).—A supply of oil to be carried in a well in the engine case, and the oil from all bearings to drain back into it. From the well a pump is to force the oil into each of the bearings in succession by the action of Clarkson's patent distributor. This ensures that every bearing is properly oiled, without any further attention, than occasionally, say once a week if in regular use, adding a little oil to the well.

Lubrication (Cylinder).—The cylinders to be fed by two positive pumps contained in aluminium reservoir. The pumps to be driven by worm gearing from the engine. The lid of the reservoir to cover a large opening, and to be quickly removable for inspection and refilling.

Pumps.—Four bronze force pumps to be driven direct from the differential shaft, to deal with the boiler feeding, return water, fuel and lubricating oil. The pumps to be fitted with "Clarkson's" patent high speed valve box, and to be interchangeable. A pump to be also fitted for filling the boiler by hand.

Piping.—All pressure pipe lines to be made of seamless steel. Joints to be flanged and secured by steel unions.

Tanks.—A galvanized iron water tank of not less than 25 gallons capacity to be fitted with drain cock, filling and suction strainer, and filter box. Part of the top to be made removable for inspection and cleansing. The *Main Fuel Tank* to be made of sheet steel, riveted together and galvanized. Capacity not less than 25 gallons. To be fitted with glass gauge and graduated scale, filling and suction strainers. Part of the top to be made removable for inspection and cleansing. The *Pressure Tank* to be of seamless steel, and to be tested to 200 lbs. per square inch by hydraulic pressure.

Valves, Gauges and Fittings.—These to be all of the highest class, and of practical construction.

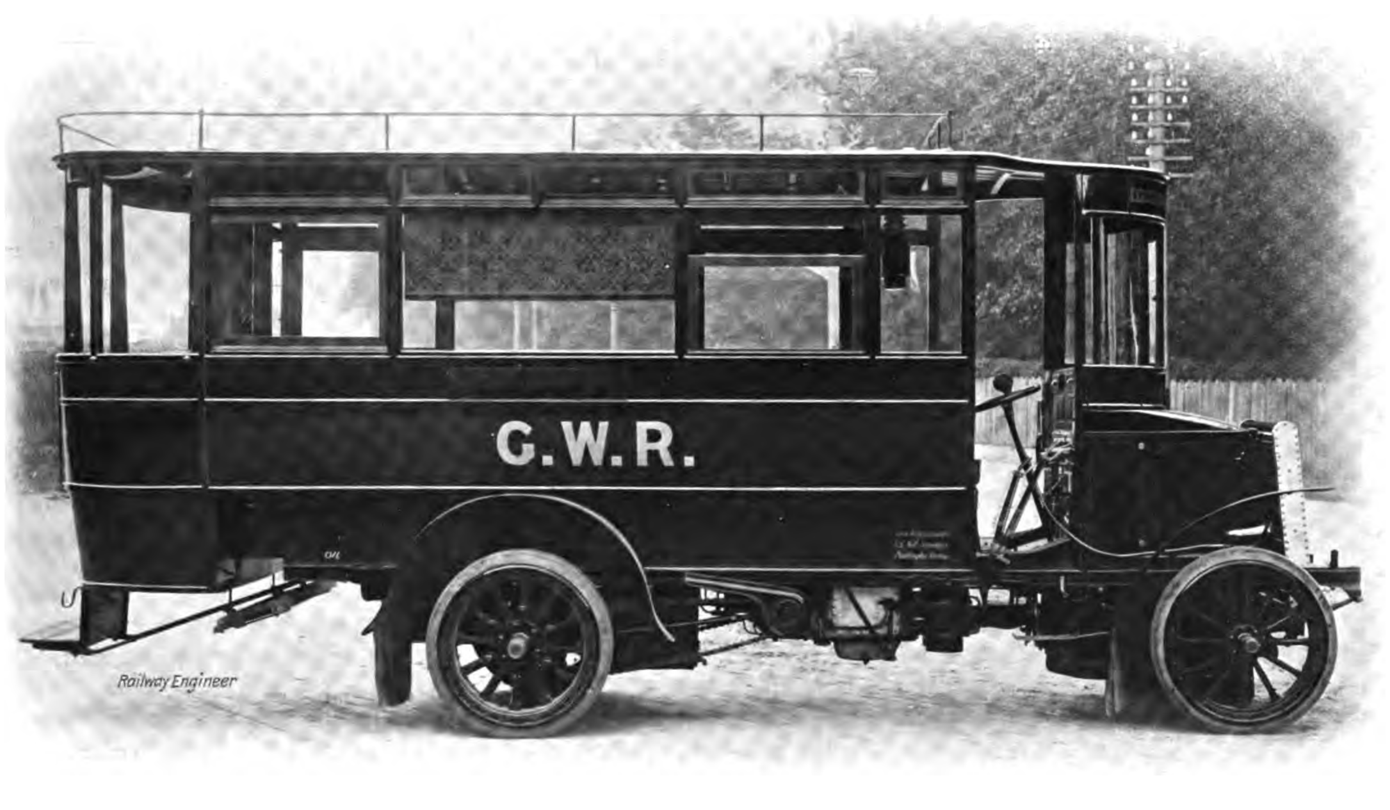
Brakes.—There are to be two independent brakes, acting directly upon the driving wheels; an outer band brake worked by a foot lever, and an inner band brake worked by hand and capable of locking. Both brakes to have metallic surfaces.

Steering.—This to be operated by a wood-rimmed wheel suitably connected to the Akerman axle.

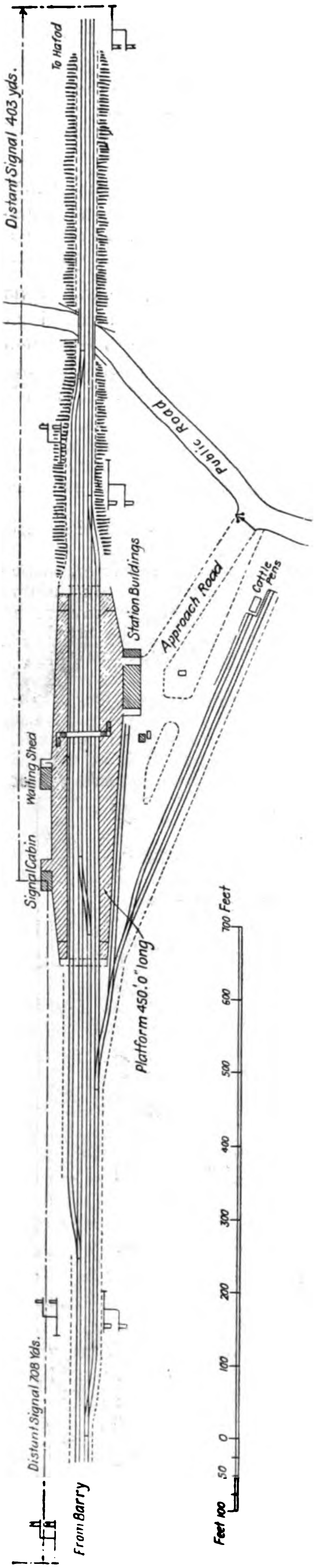
Condenser.—The condenser to be of rectangular form, to be made of "Clarkson's" patent tubes, fitted into aluminium side pockets, partitioned to cause the steam to traverse a long path. A water pocket or "hot well" to be fitted, to collect the condensed steam, and any uncondensed vapour to be permitted to escape.

Driving Chains.—Steel roller chain $1\frac{3}{8}$ ins. pitch, test breaking load 4 tons.

Wheels.—34 ins. diam., artillery pattern, with steel hubs, cleft oak spokes, and ash felloes. Tyres on front wheels, single, $3\frac{1}{2}$ ins. solid rubber, and on the back wheels $3\frac{1}{2}$ ins. with solid rubbers.

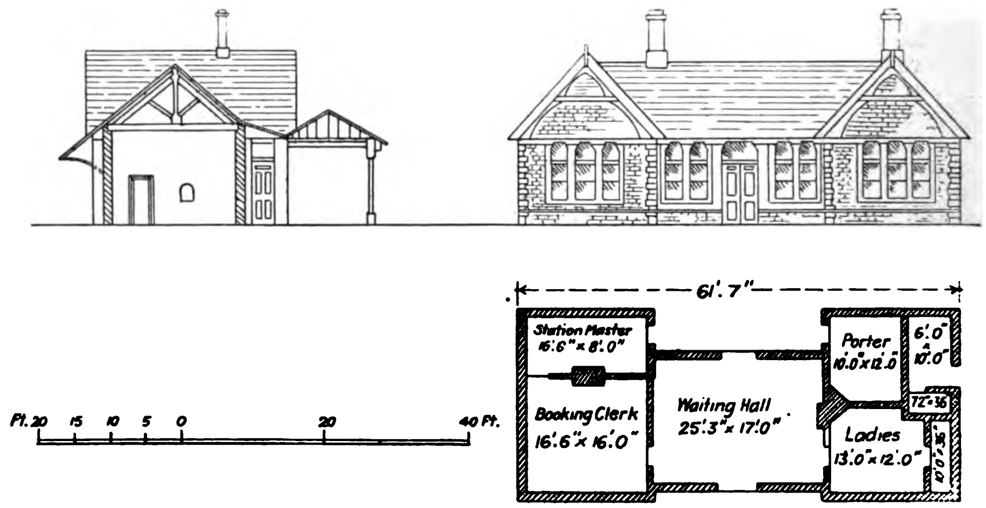


Chelmsford Motor Omnibuses, Great Western Railway.



Efail-Isaf Station, Barry Railway.

Wenvoe Station, Barry Railway.



Efail-Isaf Station, Barry Railway.

Efail-Isaf and Wenvoe Stations: Barry Railway.

Modern Railway Stations.—III.*

We are indebted to Mr. Wm. Waddell, M.Inst.C.E., engineer of the Barry R., for the annexed drawings of Efail-Isaf Station, and also for the photograph of Wenvoe Station, both of which are country stations of the same class on the main line from Barry to Hafod.

These stations have been built about nine years, and their accommodation is generally considerably in excess of the present requirements, but the great convenience of the arrangements, both of the building and station-yard, is fully appreciated by the public and the company's servants.

The station buildings are constructed of pressed Cattybrook red bricks with Forest of Dean quoins. The entrance is straight through the waiting hall (25 ft. 3 ins. × 17 ft.) off which the other rooms lead, as shown on the plan. The station-master's office (16 ft. 6 ins. × 8 ft.) has also an entrance off the platform, but the porters' room, (10 ft. × 12 ft.) has only an entrance off the platform. The ladies' waiting room is 13 ft. × 12 ft. The total length of the station building 61 ft. 7 ins.

The platforms are 450 ft. long, and have a width of 25 ft. at the widest part. The surface is gravel, with a coping of York stone 18 ins. wide. The platforms are connected by an over foot-bridge for passengers, and there are the usual ramps and crossings at each end. On the platform, or down side, there is an iron and glass verandah the whole length of the station building for the protection of passengers.

* No. I., Badminton, G. W. R., September, 1904; No. II., Walkerburn, N. B. R., December, 1904.

It will be noticed that there are two through and two platform lines through the station, and that the passing loops are of considerable length, this being necessary owing to the line being crowded with long mineral trains. There is a crossover just in front of the signal box, between the two through lines.

The yard is provided with sidings for loading and discharge of goods, and there are cattle pens and loading banks for wagons.

The cost of these stations, including platforms, buildings, approach roads, &c., was about £5,000 each.

Powles and Moore's Patent One-Wire Block Instrument.

We were recently afforded an opportunity of inspecting, at the works of the manufacturers, Messrs. P. Walters & Co., Kensal Town Telegraph Works, London, the new "One-Wire" Block instrument, and which the firm is now manufacturing in considerable quantities, chiefly for Foreign and Indian railways.

It will be seen from the external view, fig. 1, that the appearance of the instrument is similar to that of ordinary block instruments.

The upper or dial portion of this instrument consists of two electric miniature semaphore arms. The upper one represents the starting-signal, and is worked from the cabin in advance. The lower arm represents the starting-signal of the cabin in the rear, for a train coming from that direction. The upper semaphore is manipulated by the signalman in the advance cabin, and cannot be altered in any way by the commutator of its own instrument. The lower semaphore is worked by the outgoing current sent by the commutator of the instrument, and is synchronous in its movement with the upper semaphore arm on the instrument in the rear cabin of the section to which it is connected.

The visual signals being in the form of miniature semaphores, the signal received in reply to "is line clear" is unmistakable, as the semaphore arm either remains at danger with the answering bell signal, or is lowered to "line clear" position.

The movement of the miniature semaphore therefore leads the position that the outdoor starting-signal should be put to.

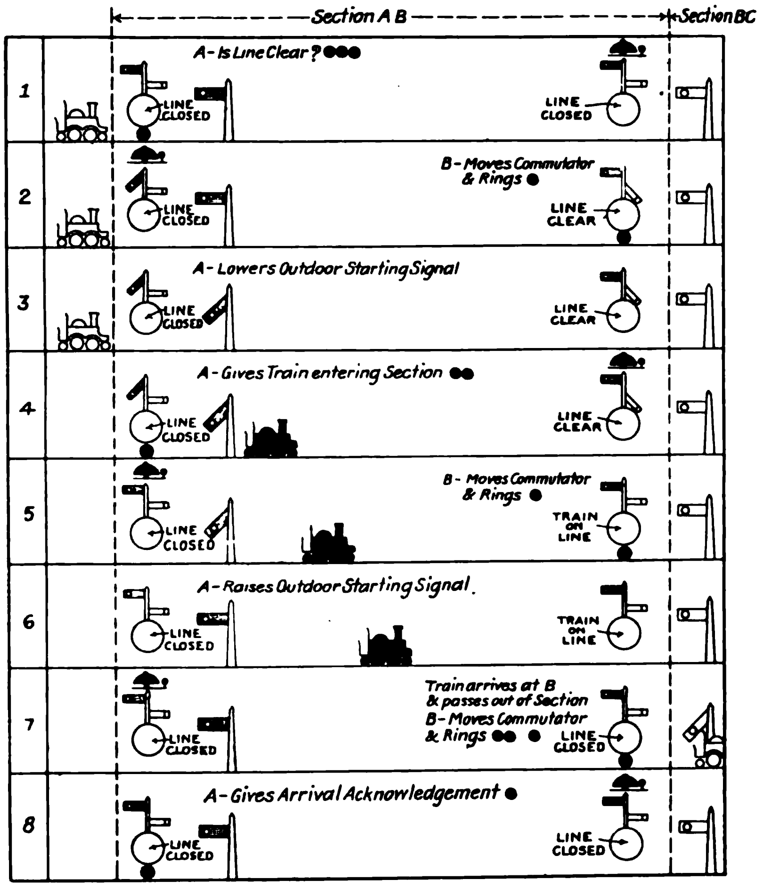
A signal sent when the commutator indicates either "line closed" or "train on line," puts its own lower miniature semaphore, and the rear cabin's upper miniature semaphore,

Mode of Working Powles & Moore's Block Instrument for Single or Double Lines.

Train travelling from A to B.

Outdoor Signal— Starting Signal for Up Line, Section AB. Train going from A to B.	Outdoor Signal — Starting Signal for Up Line, Section BC. Train going from B to C.
Upper Miniature Semaphore — Leads position for above Starting Signal.	Upper Miniature Semaphore—For train going to A. Leads position for Starting Signal, Down Line (not shown below).
Lower Miniature Semaphore—For train coming from B. Indicates position of Upper Semaphore at B.	Lower Miniature Semaphore—For train coming from A. Indicates position of Upper Semaphore at A
Indicator — Shows condition of Down Line, Section AB, Train coming from B to A.	Indicator—Shows condition of Up Line, Section AB, Train coming from A to B.

Fig. 1.



Line Closed	- - - - -	Black on White.
Line Clear	- - - - -	White on Green.
Train on Line	- - - - -	White on Red.

Fig. 2.

to the up or down danger position, but when the commutator indicates "line clear" and a signal is sent, these semaphores are lowered. The semaphores cannot be moved without giving an audible signal on the bell in the distant cabin.

It is most necessary that the signalman in advance (and who gives permission to the rear cabin to allow a train to enter the section) should know the exact state of that section. This is indicated clearly to him in clear bold type, coloured as follows :—

Line closed—black letters on white ground. Line clear—white letters on green ground. Train on line—white letters on red ground.

The commutator is arranged to show either of three indications, the one visible denoting the exact state of the section which the instrument governs.

It is compulsory, when the signalman has given "line

The whole of the exterior metal work is always at earth potential.

The ordinary code of block working can be adhered to.

Only one line-wire is required, and only one battery of from 4 to 6 Leclanche cells is necessary for each instrumen The sending line battery also acts as the local battery in the relay bell circuit.

Fig. 2 shows diagrammatically the working of a pair of these instruments. Figs. 3 to 9 show the internal mechanism by which the results enumerated above are obtained. It is strong and simple, and brass spring rubbing contacts are used throughout for the electrical connections—no silver or platinum contacts being used.

The construction and working of the commutator is as follows :—

Fig. 3.

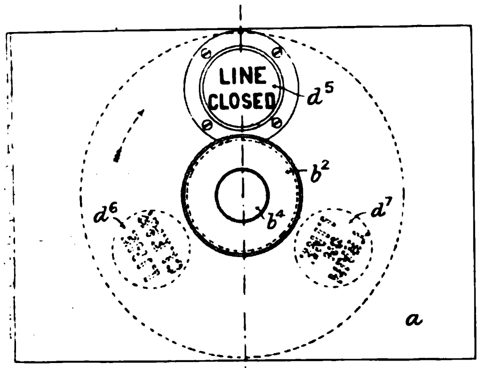


Fig. 5.

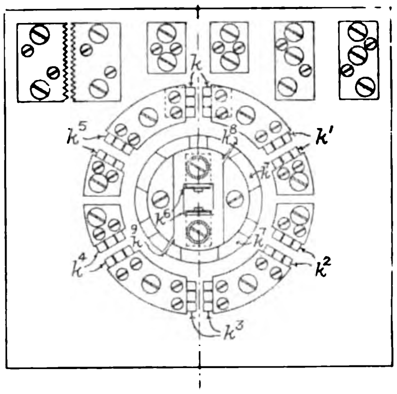
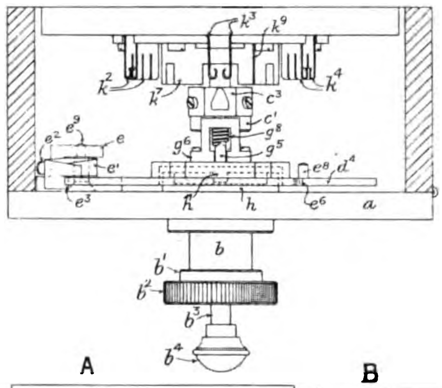
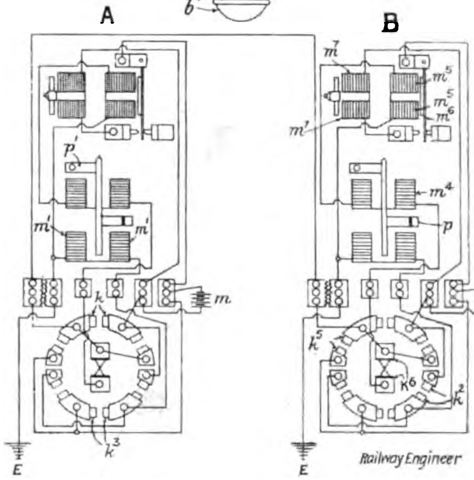


Fig. 7.





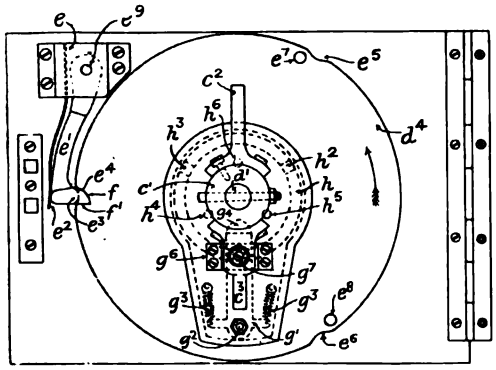


Fig. 4.

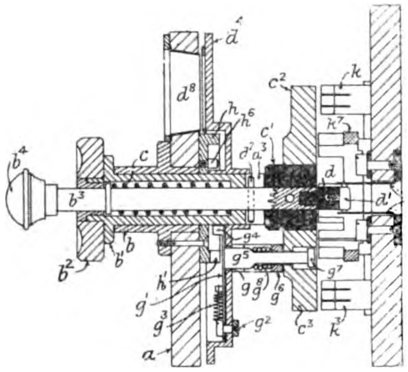


Fig. 6.

Fig. 8.

clear," that he must also send "train on line" before he can bring the instrument back to its normal position of "line closed."

For receiving trains the commutator works in a complete cycle, and once it has been turned to indicate "train on line," the instrument cannot be put to "line clear" until "line closed" has been sent.

The instrument may be put to "train on line" from either the "line closed" or "line clear" positions.

Directly the commutator is moved from one indication to another, it is locked in that position, and cannot again be altered until the plunger has been depressed, thus setting the electrical semaphores according to the indication shown by the commutator, and also ringing the bell at the other cabin.

The bell plunger is always free to be used.

The electrical commutator being circular requires the minimum number of contacts to be made, and is so arranged that it is impossible to short circuit the battery.

The plunger b^3 moves in a spring box b^1, which rotates in a bush b fixed on to the door of the instrument, fig. 6. The spring box b^1 is rotated by means of the milled finger piece b and which in turn rotates the plunger by means of the pin d^2, which slides when the plunger is plunged in a slot d^8 cut in the spring box b^1.

Towards the end of the plunger is fixed a large insulating block c^1 on to which are fixed the contact arms c^2 c^3, which make the necessary electrical connections between the pairs of contact springs, k k^1 k^2 k^3 k^4 k^5. Into the end of the plunger rod is screwed an insulating cap d, which carries a contact piece d^1 which normally makes a connection between the contact springs k^6, but when the plunger is plunged the springs pass off d^1 on to d and the connection is broken. The contact arms c^2 c^3 are of different widths and the guard ring k^7, which is a little higher than the contact springs, has three pairs of slots cut in it so that the plunger can only be plunged when it is in one of the three correct positions. The

guard ring is cut at k^8 k^9, fig. 5, so that should the arms c^2 c^3 rub on it no electrical connection is made.

The indicator plate d^4, figs. 3, 4, and 6, is rigidly attached to the spring box b^1 and it is locked in position by the bolt g^5, which is carried on the contact arm c^3 and in a rectangular hole g, with the indicator plate d^4. The bolt carries a spring in compression which normally tends to shoot it through the indicator plate, but this is prevented by a shutter plate g^1 carried on the indicator plate by a bolt g^2, on which it is free to oscillate, but is maintained in its central position closing the hole g by two spiral springs g^3. The upper part g^4 of the shutter is cam shaped, and when the indicator plate is rotated it comes into contact with one of three fixed pegs h^4, h^5, h^6, and is therefore pushed aside and allows the bolt to shoot through into one of three notches h^1, h, h^3, cut in the fixed ring h, so that the indicator plate cannot be rotated again unless the bolt be withdrawn by plunging, and thereby giving an indication to the other signal box. Directly the bolt is withdrawn the hole g is closed by the shutter g^1. The rotation of the indicating plate in the direction to give the proper sequence of signals, viz., "line clear," "train on line," "line closed," is secured by fixing a spring pawl e^1, so that it always presses on the edge of the plate and having its detent so shaped that it will allow the pins e^7, e^8, on the back of the plate, fig. 4, to pass it in one direction. But in order that the indication may show "train on line" from either of the other two indications the third pin is omitted.

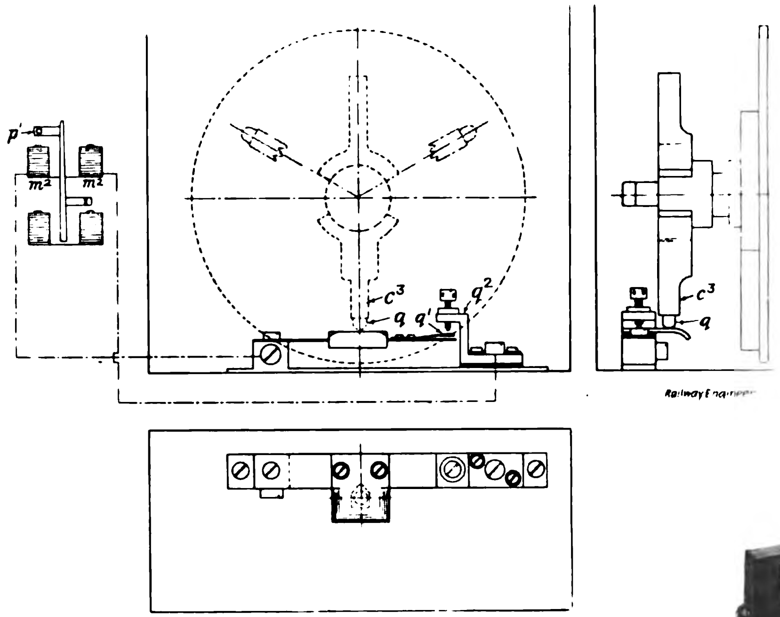


Fig. 10.

The arrangements of the circuits and working can be readily understood by referring to fig. 8. A and B shows diagrammatically two sets of complete apparatus, A being at one end and B at the other end of a section. We will suppose that a train is required to be sent from A to B, and is standing at A, both the "up" and "down" lines being closed. Both indicators show "line closed," and all miniature semaphores are at danger position. A asks B for permission to send a train by pressing his plunger. This rings B's bell, the circuits being as follows:—Starting from copper pole of battery M, the current goes through the contact maker which connects k pair of springs to "line," and along same to instrument at B. Here it goes across springs k^6 to coils m^4 m^4, from thence through the relay coils m^5 m^5 to "earth," back through "earth" to instrument A again, through coils m^1 m^1, across contact maker between springs k^3, and thence to zinc pole of battery m, thus completing the line circuit. This current on going through the relay coils m^5 m^5 of instrument B, attracts the armature m^6, and closes the local circuit which energises the coils m^7 m^7, which rings the bell. As B's indicator is showing "line closed," he knows that there is no train in the section. He then rotates the indicator plate to show "line clear," and then presses in his plunger. In this position as previously mentioned, when the plunger is pressed, springs k^6 are broken, and k^2 and k^5 respectively connected together. The electrical circuit is thus made similarly as explained with instrument A, but in this position it will be noticed that instead of the copper pole being put to line and zinc to earth, zinc is put to line and copper to earth. Thus B's bottom flag p and A's top flag p^1 will be lowered, and A's bell rung. A now seeing that his top miniature semaphore is lowered, knows that he may lower his outdoor starting signal, which he does, and the train proceeds towards B. Directly the train has entered the section, A informs B that this is so by means

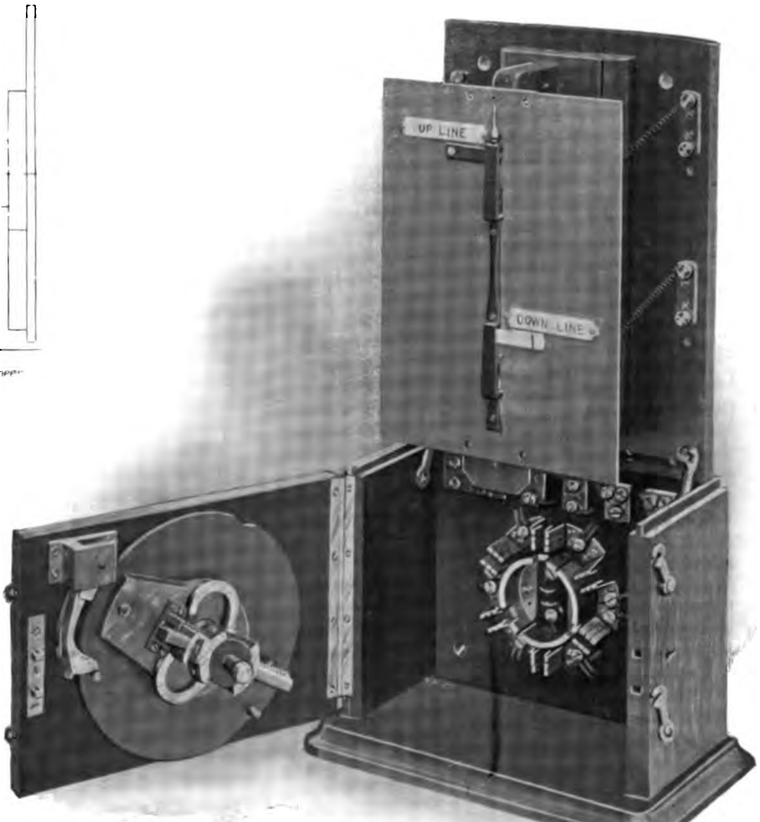


Fig. 9.

of a certain number of beats on B's bell. B then rotates his indicator plate to show "train on line" and plunges, that is copper is put to line and zinc to earth. This raises the miniature semaphores p and p^1, and rings A's bell. The train is now in the section proceeding towards B, and B's indicator is showing "train on line." When the train arrives at B, and passes out of the section, B rotates his indicator plate to show "line closed," and presses his plunger the requisite number of times to give the code signal on A's bell, and as the battery current is in the same direction as for "train on line," the miniature semaphores remain at danger.

These instruments have also been adapted for use on single lines and at junctions.

When used on single lines, a make and break switching arrangement is added, so that when A's instrument has its indication showing anything else but "line closed" the top miniature semaphore coils are short circuited and no current can energise them. The way in which this is done is easily followed on fig. 10. The normal position of spring q^1 is to press against contact screw in q^2. On the end of the contact arm c^3 is a pin q of sufficient length to press down spring q^1 and break connection with q^2 when in the "line closed" position, and on the contact arm c^3 being moved from the "line closed" position, the spring rises and makes contact with q^2, and thus (the electrical connections being added as shown) it follows that the coils m^2 are short circuited when the spring is in its normal position, and free to be energised when the spring is pressed by the pin on the end of contact arm c^3. Therefore when A has once given permission for B to send a train, and moved the contact arm c^3, the miniature semaphore P^1 (which leads the outdoor semaphore for trains to B) cannot be lowered by B until the train from B is out of the section, and the instrument put to "line closed."

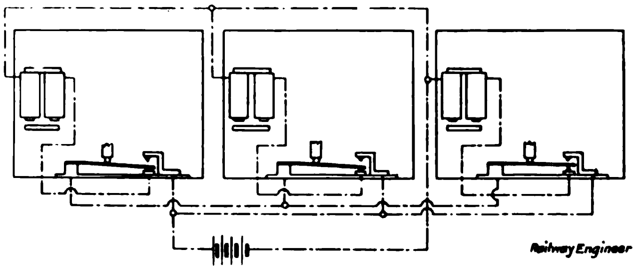


Fig. 12.

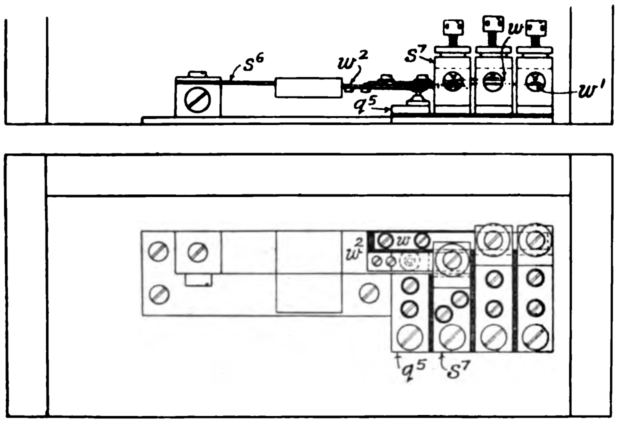


Fig. 13.

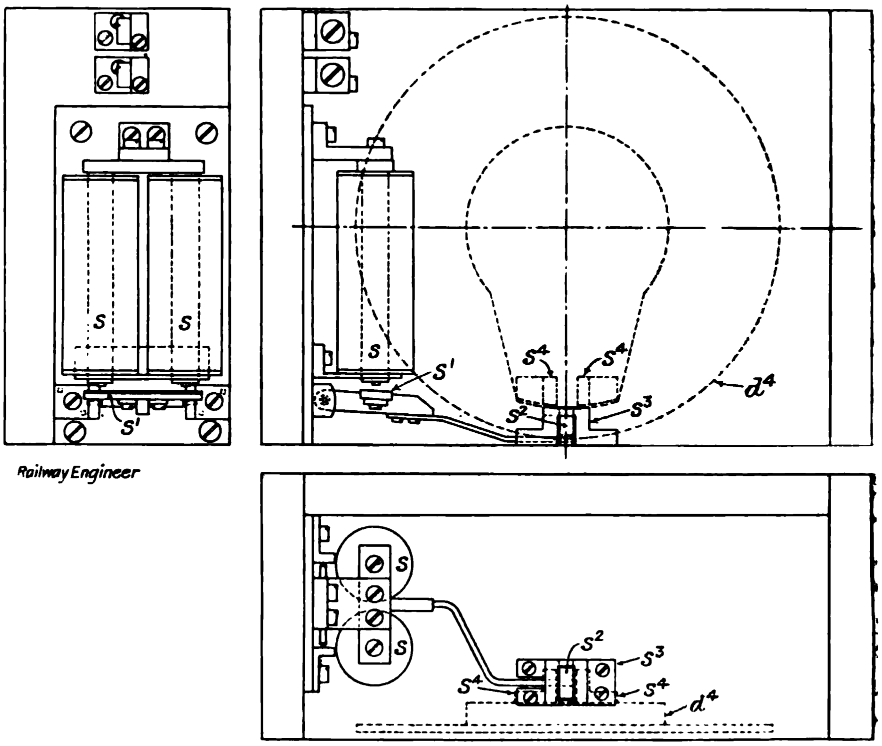


Fig. 11.

For use at junctions, the arrangement shown in figs. 11 to 13 is provided. Fig. 12 shows the extra electrical connections necessary for three sets of instruments in one signal cabin. The electro-magnets when energised attracts an armature s^1 and lifts a catch s^2 working in s^3 between the two catches s^4 which are fixed to indicator plate 14, thus locking the indicator plate and preventing any rotary motion taking place.

A similar make and break switching arrangement to that above described, fig. 10, is provided, with the addition of a bottom contact q^5. This is also worked in the same manner by means of a pin q in contact arm c^3. Thus when "line closed" is indicated, contact spring s^6 is making contact with q^5, but at either of the other two indications it breaks with q^5 and makes with contact cock s^7. Therefore when any one of two or more instruments thus connected up is moved to "line clear" or "train on line," the electro-magnet circuits of the other instruments will be complete, the armatures and catches of same will be raised, and the rotary motion will be locked and cannot be moved from "line closed" until the other instrument is put to the position "line closed."

Where junction and single line working are required together, the working is combined in the one switching arrangement as shown in fig. 13. The miniature semaphore coils m^2 are short circuited through the contact springs w w^1, which are insulated from the spring plate w.

Railways and the Board of Trade.—I.

The relations between the Board of Trade and British railways are extensive and peculiar.

They are laid down in Acts of Parliament passed in 1840, 1842, and 1845, but were confirmed and added to by the Regulation of Railways Act of 1871 (34 and 35 Vict., Ch. 78).

By the Act of 1840 the Board of Trade were authorised to appoint any person to inspect any railway or to enquire into the cause of any railway accident, but it was provided that no person so appointed shall exercise any powers of interference in the affairs of any company.

The powers of such inspectors are defined as follows:—

(1) He may enter and inspect any railway, and all the stations, works, buildings, offices, stock, plant, and machinery belonging thereto.

(2) He may by summons under his hand require the attendance of any person who is engaged in the management, service, or employment of a company, and whom he thinks fit to call before him and examine for the said purpose, and may require answers or returns to such enquiries for the said

purpose as he thinks fit to make from such person or company.

(3) He may require and enforce the production of all books, papers, and documents of a company which he considers important for the said purpose.

From the foregoing it will be seen that the powers of a Board of Trade inspector are very extensive, although they are rarely, if ever, acted up to, and it is doubtful whether more than a few railway officers are aware of the extent of the authority with which railway inspectors are endowed.

The original Acts only required new railways to be offered to the Board of Trade for inspection. By the Act of 1871 these powers were extended to "the opening of any additional "line of railway, deviation line, station, junction or crossing "on the level, which forms a portion of, or is directly "connected with, a railway on which passengers are conveyed, "and has been constructed subsequently to the inspection of "such railway on behalf of the Board of Trade previous to the "original opening of such railway."

From the above quotation it will be seen that only lines on which *passengers* are conveyed have to be inspected, and, therefore, lines used purely for goods and mineral traffic need not be offered for inspection. Neither need private railways be inspected, even though workmen and others are regularly carried free over them.

It will be noted that not only must additional lines, junctions (which includes siding connections and cross-over roads), and crossings on the level (those similar to Newark, S & D crossing Darlington, &c.) must be offered, but all deviations of the line and any new stations, whether alterations are made in the main line or not.

The Act (1871) does not, however, provide for any alterations in the permanent way to be offered for inspection that do not cause an additional connection in the railway. But most railway companies do submit such cases, and therefore, make sure of complying with the law.

The penalties for using a railway or new connection without having offered it to the Board of Trade for inspection is £20 per day.

The same Act (1871) also lays down the regulations as to reporting accidents to the Board of Trade. It provides that where in or about any railway or any of the works or buildings connected with such railway, or any building or place, whether open or enclosed, occupied by the company working such railway, any of the following accidents take place in the course of working any railway:—

(1) Any accident attended with loss of life or personal injury to any person whomsoever;

(2) Any collision where one of the trains is a passenger train;

(3) Any passenger train or any part of a passenger train accidentally leaving the rails;

(4) Any accident of a kind not comprised in the foregoing descriptions, but which is of such a kind as to have caused or to be likely to cause loss of life or personal injury, and which may be specified in that behalf by any order to be made from time to time by the Board of Trade.

The company working such railway, and also if the accident happen to a train belonging to any other company, such last-mentioned company shall send notice of such accident, and of the loss of life or personal injury (if any) occasioned thereby, to the Board of Trade.

The notices are to be sent in such form and shall contain such particulars as the Board of Trade may from time to time direct and shall be sent by the earliest practicable post after the accident takes place.

Powers are further given to the Board to require such notices to be sent by telegraph should they see fit to issue instructions to that effect.

The penalties for failing to comply with these instructions as to accidents is a fine not exceeding twenty pounds.

Board of Trade enquiries, by their inspectors, into such accidents as they considered fit had already been sanctioned by former legislation, but the Act of 1871 gave them further powers.

One had relation to the appointment of an assessor to assist the inspector, and this section of the Act goes much further. It says:—

(1) The Board of Trade may by the same or any subsequent order, appoint any person or persons possessing legal or special knowledge to assist an inspector in holding the same or may direct the county court judge, stipendiary magistrate, metropolitan police magistrate, or other person or persons named in the same or any subsequent order, to hold the same with the assistance of an inspector or any other assessor or assessors named in the order.

(2) The persons holding any such formal investigation (hereinafter referred to as the court) shall hold the same in open court in such manner and under such conditions as they may think most effectual for ascertaining the causes and circumstances of the accident and enabling them to make the report in this section mentioned.

(3) The court shall have for the purpose of such investigation all the powers of a court of summary jurisdiction when acting as a court in the exercise of its ordinary jurisdiction and all the powers of an inspector under this Act, and in addition the following powers, namely:—

(a) They may enter and inspect any place or building, the entry or inspection whereof appears to them requisite for the said purpose.

(b) They may by summons under their hands require the attendance of all such persons as they think fit to call before them and examine them for the said purpose, and may for such purpose require answers or returns to such enquiries as they think fit to make.

(c) They may require and enforce the production of all books, papers and documents which they consider important for the said purpose.

(d) They may administer an oath and require any person examined to make and sign a declaration of the truth of the statements made by him in his examination.

(e) Every person so summoned, not being a person engaged in the management, service or employment of a company or otherwise connected with a company, shall be allowed such expenses as would be allowed to a witness attending on subpœna before a court of record; and in case of dispute as to the amount to be allowed, the same shall be referred by the court to a master of one of the superior courts, who, on request under the hands of the members of the court, shall ascertain and certify the proper amount of such expenses.

(4) The inspector making an enquiry into any accident, and the court holding an investigation of any accident, shall make a report to the Board of Trade stating the causes of the accident and all the circumstances attending the same, and

II.

______ *Railway.*

Table of Gradients and Level Portions.

*Fixed Point** ______ *Datum Level* ______

Distance from fixed Point at which Gradient				Height above Datum Level		Length		Rate of Inclination
Commences		Terminates		At Commencement	At Termination			
Miles	Chains	Miles	Chains	Feet*	Feet	Chains	Links	

* State the Position of the fixed Point to which the distances are referred, and of that from which the Datum Level is taken, and fill up the columns of Heights in Feet and Decimals.

III.

______ *Railway.*

Table of Curves and Straight Portions.

*Fixed Point** ______

Distance from fixed Point at which Curve or Straight Portion				Length		Radius	Side to which it bends
Commences		Terminates					
Miles	Chains	Miles	Chains	Miles	Chains	Chains	

* State Position.

IV.

______ *Railway.*

Table of Cuttings and Embankments.

*Fixed Point** ______

Distance from fixed Point at which Cutting				Distance from fixed Point at which Embankment				Length	Greatest height or depth to formation Level	Cubical Content †	Slope in proportion of Base to Perpendicular		Nature of Material, with any peculiarity of formation, and whether subject to the action of water or land Springs; and when the sides of Cuttings or Embankments are supported by retaining walls, state their height and form, materials of which constructed, the thickness at top and bottom, and number; interval between and dimensions of Counterforts, if any; with a Diagram, in case of any peculiarity in construction.
Commences		Terminates		Commences		Terminates							
Miles	Chains	Miles	Chains	Miles	Chains	Miles	Chains	Chains	Feet		Base	Perpendicular	

* State Position.—In Filling up this Table, it is requested that the Cuttings and Embankments may succeed each other in the proper order of position.
It is requested that the Content may be inserted if it can be so without inconvenience.

V.

______ *Railway.*

Table of all Bridges either under or over the Railway.

*Fixed Point** ______

Distance from fixed point of the centre of the road		Name of Bridge	Whether across Road (Public or Occupation), Railway Canal, or Stream	If Road, leading †		Whether over or under the Railway	GIRDER OR ARCHES. Number of openings	Description of Girder or form of Arch	Square or Skew and Angle	Span		Rise of Arch	Thickness of Arch		Width between Parapets	Height from Rails or level of Road to Springing of Arches or underside of Girders	Nature of Material		REMARKS.
										Square	Skew		Crown	Springing			Girders or Arches	Abutments and Piers	
Miles	Chains			From	To					Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.				

N.B.—In respect of Bridges of Masonry or Brickwork, as their strength depends in a great measure upon the dimensions of the Piers and Abutments, and on the number, position, and dimensions of their Counterforts, which are concealed from sight after the work is finished, information as to these details may be requested at the period of inspection.

* State position. † Under this head specify between what Places each Road Communicates.

VI.

_____ *Railway.*

Table of Viaducts carrying the Railway. *Fixed point** _____

Distance from fixed point at which Viaduct commences		Length in Yards	Name of Viaduct	GIRDERS OR ARCHES.								Clear width between the Parapets	Extreme height from the bottom of river or brook or the lowest part of the valley to the level of the rails	Nature of Material		REMARKS.
				Number	Description of Girder or form of Arch	Square or Skew and Angle	Span		Rise of Arch	Thickness of Arch.				Girders or Arches	Abutments and Piers.	NOTE.—Any peculiarity in the construction of the piers or abutments, also any difficulty in the foundations, should be remarked.
Miles	Chains						Square Ft. In.	Skew Ft. In.	Ft. In.	Crown Ft. In.	Springing Ft. In.	Ft. In.	Ft. In.			
																N.B.—In the event of there being any tubular bridges upon the railway through which trains pass, state the internal dimensions as to width.

N.B.—In respect of Viaducts of Masonry or Brickwork, as their strength depends in a great measure upon the dimensions of the Piers and Abutments, and on the number, position, and dimensions of their Counterforts, which are concealed from sight after the work is finished, information as to these details may be requested at the period of inspection.

* State position.

VII.

_____ *Railway.*

Table of all Level Crossings.

*Fixed Point** _____

Distance from Fixed Point		Description of Road, whether Turnpike, Parish, Private, Bridle, or Footpath		Leading		Gates, whether capable of shutting across the Railway	Whether Lodge or Gamekeeper is provided
Miles	Chains		No. of Road on Parliamentary Plan	From	To		

* State position.

VIII.

_____ *Railway.*

Table of Tunnels.

*Fixed Point** _____

Distance from fixed Point at which Tunnel begins		Length	Intervals between recesses	Material with which lined	Description, stating the shape and dimensions of the various parts with an explanatory section shewing the construction and thickness of materials; also state whether built in cement or lime mortar, or both, and of what sort; also the nature of the formation through which it passes, and whether subject to the action of water, and in what quantities; also the mode of draining and the system of ventilation.
Miles	Chains	Yards			

* State position.

IX.

_____ *Railway.*

Table of Aqueducts and Culverts 3 feet or more in diameter or width.

*Fixed points** _____

Distance from fixed Point.		Width or Diameter	Description of manner in which the Water is conveyed across or under the Railway, with the available Section of the Aqueduct or Culvert, and its fall.
Miles	Chains		

* State Position.

any observations thereon or on the evidence or on any matters arising out of the investigation which they think right to make to the Board of Trade, and the Board of Trade shall cause every such report to be made public in such manner as they think expedient.

The same Act (1871) also provided for an important public service in reference to coroner's inquests on persons killed in railway accidents.

It provides that, where in England a coroner is holding an inquest on the death of any person occasioned by an accident, the coroner, on written application to the Board of Trade, may have the assistance of an inspector or some person possessing legal or special knowledge appointed by the Board. The person so appointed shall act as assessor to the coroner and report to the Board of Trade.

It is the Act of 1871 which provides for annual statistics to be sent to the Board of Trade by the companies as to their capital, traffic and working expenditure.

The Board of Trade comes into contact with railways in connection with the following matters:—

1. Opening of new lines and alterations to existing railways.
2. Accidents on railways.
3. Continuous brake failures.
4. Hours of duty of servants.
5. Workmen's trains.
6. Accidents to railway servants.
7. Railway statistics.

Inspection of New Works.—It is common knowledge that before a new line can be made parliamentary sanction has to be obtained. One of the preludes to this is the deposit of the parliamentary plans with certain governmental and local authorities, one of which is the Board of Trade.

These are referred to the chief inspecting officer of railways, and one of his duties is to see that no public road level crossing is proposed. It is now practically impossible to get sanction for a public road to cross a line on the level, unless it be the case of a light railway. Nor will any additional lines of railway across a public road crossing be sanctioned. Where bridges or subways are proposed in lieu of level crossings, the Board of Trade see that the gradients proposed for approaching the same are not too severe.

The question of level crossings is considered thus early, as were the matter to stand over until the line were constructed and objections raised then, it would lead to unnecessary expense.

That ordeal and the subsequent parliamentary stages having been passed, the capital raised, and the construction proceeded with, the line approaches completion.

A month before the line is to be opened notice has to be sent to the Board of Trade intimating the intention of the company to open such a line.

Ten days before the date of opening a second notice must be given, which notice must be accompanied by the following documents:—

I. Copies of the parliamentary plans and sections, with any deviations which may have been made during construction marked thereon in red; and with the corrections in the distances, levels, inclinations, sections of ground, and radii of curves, rendered necessary by such deviations, also marked in red. The positions of the several stations and the lengths and heights of the platforms must also be given.

II. A table of gradients and level portions, with the positions of the stations distinctly shown.

III. A table of curves and straight portions.

IV. A table of cuttings and embankments.

V. A table of all bridges, either under or over the railway.

VI. A table of viaducts carrying the railway.

VII. A table of all level crossings of public occupation, private and bridle roads, and footways.

VIII. A table of tunnels.

IX. A table of aqueducts and culverts 3 feet or more in diameter or width.

The particulars II. to IX. must be supplied according to the prescribed forms (shown below).

The situations of works, &c., should be described by reference to the same fixed point; and it will be convenient if the station nearest to the head-quarters of the company for a main line, or the junction with the main line for a branch railway, be adopted as such point of reference.

X. Detailed information under the following heads:—

1st. Permanent Way.—Whether the line be double or single, or partly double and partly single; the distances from the fixed point adopted in the forms II. to IX., at which the single portions, if any, commence and terminate—or, for a single line, at which the passing places or the sidings commence and terminate; whether the land has been purchased for an additional line of rails, or whether any other arrangements have been made with a view to adding an additional line at a future period; the width at formation level; the gauge; the space between the lines and between the lines and sidings; the description, with a diagram section, of rails employed, their length and weight per yard; the description and weight of chairs, where these are employed; the mode of fixing chairs and securing rails; the fastenings adopted for the joints of rails; the description of sleepers with their smallest and average scantling and length, their distance from centre to centre if transverse, and if longitudinal, the details of any ties by which they may be connected; the nature of the ballast and its depth below the under surface of the sleepers; the number and positions of all facing points connected with the main line; and the names of the stations or other places at which engine turntables are provided.

2nd. Fences.—Description of fencing adopted for the line, giving, in the case of post and rail fencing, the height of the top rail and the distance between posts, and in the case of wire fencing, the height, number of wires, distance between supports, and means of straining.

3rd. Drainage.—General description of the drainage, and if on any part of the line it has been attended with peculiar difficulty, details should be given.

4th. Stations.—Their names and distances at the commencement and termination respectively from the fixed point; the gradients on which they are situated and approached; the lengths of the platforms, and the positions of and distances between the home and distant signals.

5th. Width of Line.—The minimum space allowed at and over a height of 2 feet 6 inches above the rail level, between the sides of the widest carriages to be used, and any fixed works, such as pillars and walls at stations, abutments, piers, supports, arches, girders, telegraph and signal posts, sheds, &c., along the line. The minimum section of each tunnel to be appended, showing within it a section of the widest carriage to be used on the line.

6th. Viaducts and Bridges.—Drawings in detail of all viaducts and bridges either over or under the railway, accompanied by sufficient information to enable the strength of each to be ascertained by calculation and showing by sections the distances between the girders and the sides of the widest carriages to be used on the line, when the girders are more than 2 feet 6 inches above the level of the rails. The weight of each main girder and the total weight of the superstructure (including ballast if used) of all girder spans to be stated on the plans.

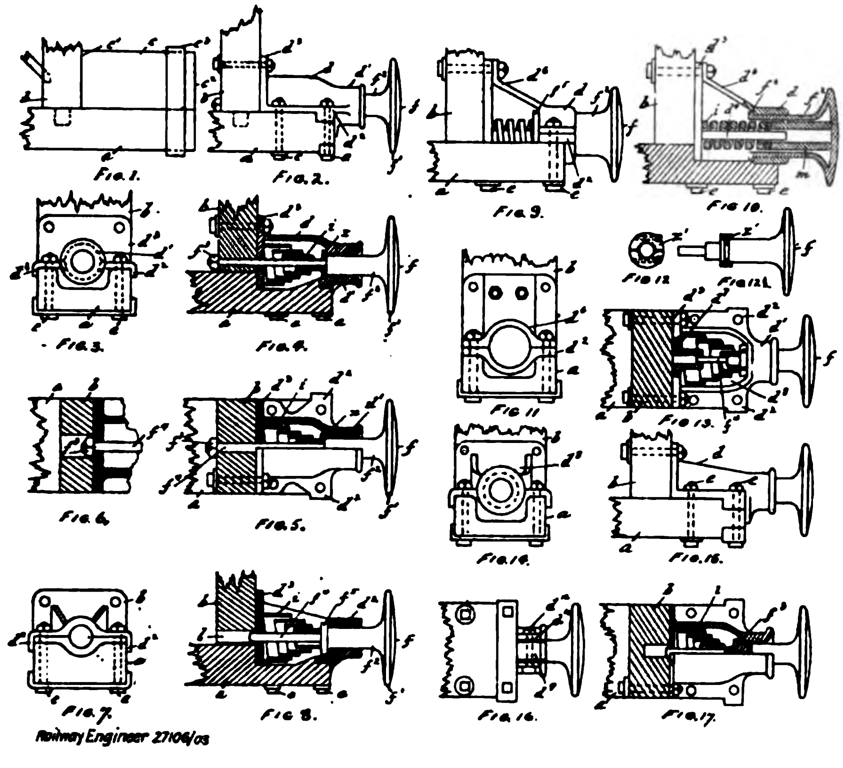
7th. Diagrams of all Junction and Station Arrangements, including Plans and Sections of the Stations, Platforms, Approaches, &c.—The foregoing particulars will be readily understood, and it only remains to be said that the information as to the signals, referred to in clause 4, is generally given in the shape of a signal diagram showing the signalling for each place. On the diagram is marked the positions of the signal boxes, signals, and points, also information as to the number of levers in the locking-frame and how they are utilized.

(To be continued.)

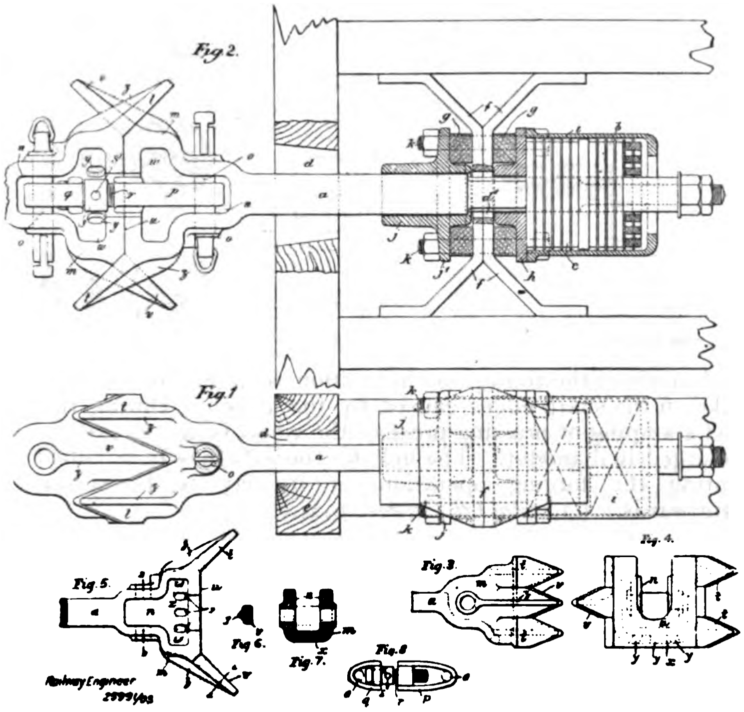
Recent Patents relating to Railways.

These abridgments of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d*. each.

Buffers. 27106. 11th December, 1903. G. Turton, 20, Montgomery Road, Sheffield.
This invention relates to the conversion of dead buffers into spring buffers by the application of a spring buffer of special form. A portion *c* of the dead buffer is removed, and a buffer box or case *d* open on the lower side is bolted to the projecting end of the sole bar *a*, and to the headstock *b*. The plunger *f* has a shank and spindle formed integral with it, the latter being provided with an india-rubber or steel spring which bears against a washer on the spindle interposed between the spring and shank. The inner end of the spindle passes through the back of the case and the headstock *b*, and is secured by a nut or cotter. It is necessary to cut away a portion of the wood of the projecting end of the sole bar to make room for the spring. Other forms of the invention are shown, but it will be seen that in all cases the buffer case forms a stay or angle piece, binding and supporting the side frame projection with the end of the vehicle frame. *(Accepted 27th October, 1904.)*



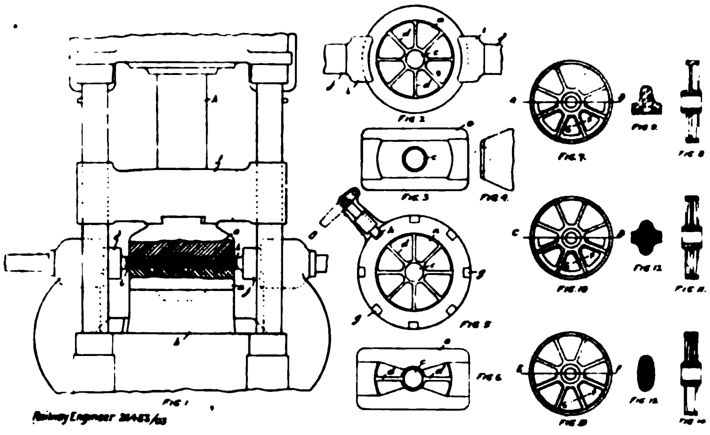
Central Buffer Coupling. 25991. 27th November, 1903. A. Spencer, 77, Cannon Street, London.
The buffer head is formed with a recess *n*, across which



extends a coupling pin *o*, and is provided at one side of its flat outer face with flange like lugs *t t* inclined outwardly, and at the other side with a similar lug *v* arranged to pass between the lugs *t* of an adjacent vehicle. A coupling device, consisting of two links or shackles *p q* connected by a screw *r*, engages the pins *o*. After the two links or shackles have been engaged with the coupling pins, the screw is tightened up by a bar inserted in one of the holes s^1 formed in an enlarged part *s* of the screw. An enlargement in the vertical recess *n* and buffer head facilitates the insertion of the operating bar, whilst holes *y* in the bottom of the recess serve the same purpose, and also for holding the bar against the screw to prevent its turning backwards accidentally. *(Accepted 29th September, 1904.)*

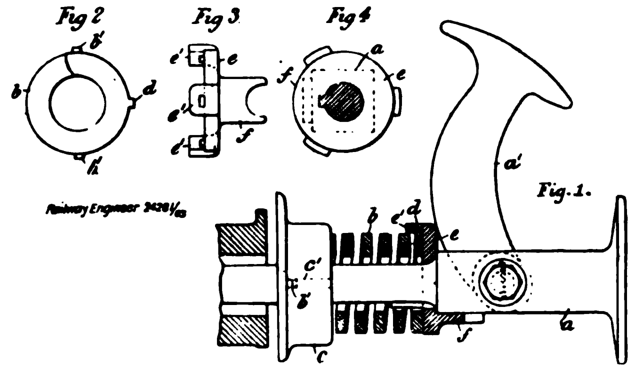
Wheels. 26483. 3rd December, 1903. John Baker and Co., Limited, and G. Baker, Brinsworth Iron Works, Rotherham.
In the manufacture of wheels and wheel centres, an ingot, or a blank of iron or steel, or other suitable material prepared to a certain extent by rolling, pressing, or hammering, whilst in a heated condition is placed centrally on a lower die, *a*, pressure is applied to the main ram *k*, forcing an upper die *e*, on to and into the heated metal, causing the metal to spread in all directions, and to fill up the recesses *c c*, in both dies, and such of the grooves, *d d*, as lie between them. Against that portion of the metal which spreads over the edge of the lower die, horizontal side dies, *i i*, are forced, pressing the metal against the edge of both upper and lower dies, and so forming part of the wheel rim. The pressure is then eased off, the lower die partly rotated and re-set when the operation is repeated. This is continued until the whole of the wheel

blank has been pressed or manipulated, or until the web or fin of metal between the spokes is sufficiently reduced. If necessary the wheel blank may be reheated during these operations. The resultant wheel has a web or fin of metal between the spokes which is now punched or otherwise cut out. If necessary, the wheel may be further pressed or stamped in dies in order to straighten and bring the spokes



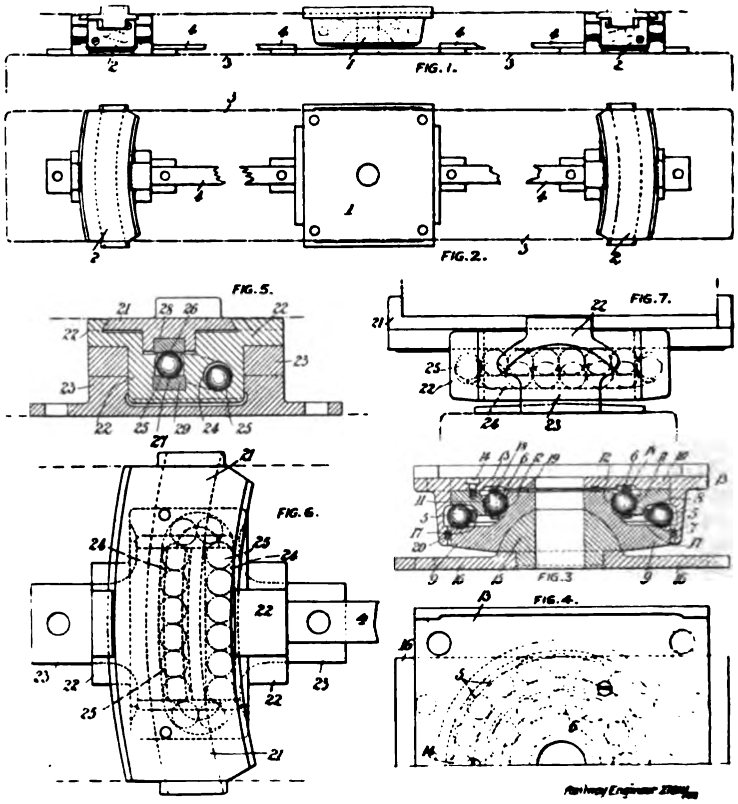
and inside of the rim up to the section required, and also to take off the sharp edges caused by the punch. During this last stamping or pressing process, the wheel is not necessarily enlarged in diameter. The hole for the axle may be punched during the forging operation, or it may be bored out afterwards. *(Accepted 6th October, 1904.)*

Couplings. 24281. 9th November, 1903. A. H. Darwin and H. Sharp, Stocksbridge Works, near Sheffield.
This invention relates to central couplings of the type known as "Jones" buffers, and to an arrangement for preventing the coupling turning about its shank. The buffing spring is provided with externally forged nibs or projections at both ends, the number of which may vary, those on the base fit into grooves in the spring cup in the usual manner, but those on the outer end of the spring fit into rectangular holes in a specially formed metal washer. This washer has a hole in



the centre, through which the shank of the buffer passes close to the head, and it takes the place of the circular washer now generally in use, and has preferably at its highest point a rearwardly extending lug, a hole in which engages the nib or projection on the outer end of the spring, or a number of lugs and nibs may be employed. The washer has formed upon the outer side another lug upon which the underside of the head of the buffer can slide, but not turn round or twist. It is preferable to have this lug or guide on the underside, as in this position it least interferes with the other fittings. *(Accepted 13th October, 1904.)*

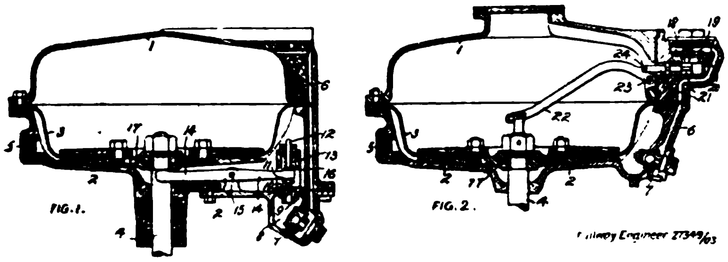
Ball Bearing Bogie Centres and Friction Blocks. 27811. 18th December, 1903. The Hoffman Manufacturing Co., Ltd., King's Head Court, Beech Street, London, and Chelmsford, Essex, and W. B. Mair, Martin Villa, Baddow Road, Chelmsford.
This invention relates to pivot and side bearers for bogie trucks, and consists in forming the bearers with a seating of spherical or similar shape, which will allow of the necessary tilting movement due to the swinging or twisting of the carriage when passing over inequalities in the levels of the track or round curves. In the case of the central or pivot bearer 1 a ring of balls 5 is arranged to take the weight or thrust of the carriage, and a further ring 6 to take the pull, the thrust balls 5 running in grooves 7 and 8 formed respectively in a "cone" portion 9 and a "cup" portion 10, the latter having on its inner side a cylindrical surface 11 between which and a groove 12 in the "cone" 9, the journal balls 6 are inserted, their points of contact being at right angles to those of the thrust balls 5. The "cup" portion 10 is retained in position in a casing 13 by set screws 14, and the "cone" portion 9 seats on an internal spherical boss or part 15 which forms the pivot and is carried by the base piece 16 of the bearer. Or, as an alternative construction, the "cone" portion may be externally shaped to seat in an internal spherical shaped recess. In either construction the "cone" portion is free to rock between the part of the



bearing held by the frame of the carriage and the part containing the spherical boss held by the corresponding part of the bogie truck. The side bearers 2 consist of a track 21 carried by the carriage or the like and a part 22 capable of rocking on trunnions or segmental seats 23, the rocking part 22 having formed in it a continuous channel 24 filled with a number of balls 25, the track 21, part 22, and channel 24, being formed on a curve struck from the centre or pivot bearing. The channel 24 is tilted at an angle whereby one portion of it is effective and one part non-effective. The effective part of the channel has grooved races, 26, 27, formed in parts 28, 29, carried respectively by the curved track 21 and by the rocking part 22. With such a construction of side bearer the pressure is distributed on the movement of the carriage, the swinging movement of the bogie frame causing the balls 25 to travel out of the upper or effective part of the channel 24 into the lower or non-effective part, from whence they are returned again to the effective part. *(Accepted October 20th, 1904.)*

Vacuum Brakes. 27349. 14th December, 1903. The Westinghouse Brake Co., Ltd., and J. W. Cloud, 82, York Road, King's Cross, London.
In order to prevent the possibility of leakage taking place into

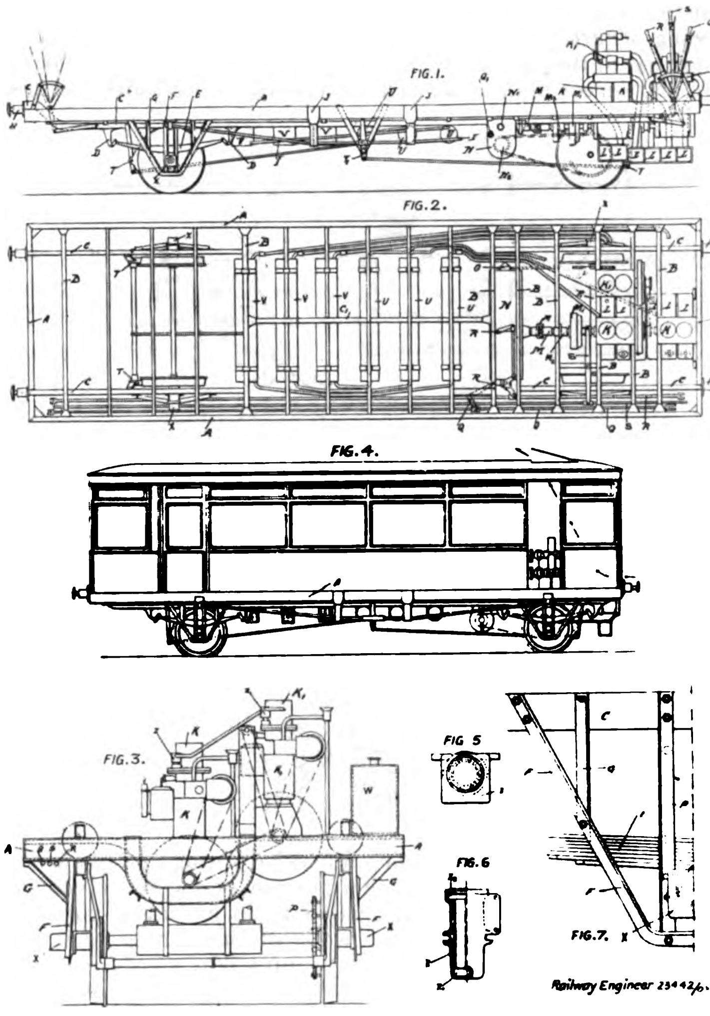
the reservoir chamber by way of the check valve, an auxiliary valve, cock, or other positive stop is interposed between the train pipe side of the piston or diaphragm and the reservoir side. In one arrangement the ball valve chamber 8 is cut off from the lower part 2 of the brake chamber by a partition 9 in which is provided a valve seat 10. With this valve seat a valve 11 co-operates, such valve being mounted upon a rod 12 with a spring 13 which tends to maintain the valve closed. 14 is a lever pivoted at 15 to the lower part of the brake chamber 2, and engaging at one end with the valve stem 12 through a collar 16, the other or inner end of said lever being operatively connected to the brake rod 4, the diaphragm plate 17 being employed in this instance as the means of operation. When air is admitted to the train pipe, the plate 17, which, during the time the brakes were released held down the inner end of lever 14, allows the lever 14 to rotate



under the action of spring 13, to close valve 11. Communication between the upper and lower parts of the brake chamber is then positively interrupted and any leakage through the ball check valve 7, prevented. In a modification the auxiliary valve is located between the ball check valve 7 and the upper chamber 1 of the brake cylinder and is constituted by a slide valve 18 provided with a port 19 and adapted to be moved to and fro on its seat 20 by means of a valve rod 21. Connected by a pin and slot connection to the upper part of the brake rod 4 is an operating lever 22 pivoted at 23 to the brake chamber, and connected also by a pin and slot connection 24 with the valve rod 21. *(Accepted 13th October, 1904.)*

Railway or Tramway Motor Car. 23442. 29th October, 1903. J. D. Roots, and The Roots Oil Motor and Motor Car, Limited, Chicheley Street, York Road, Lambeth, S.E.

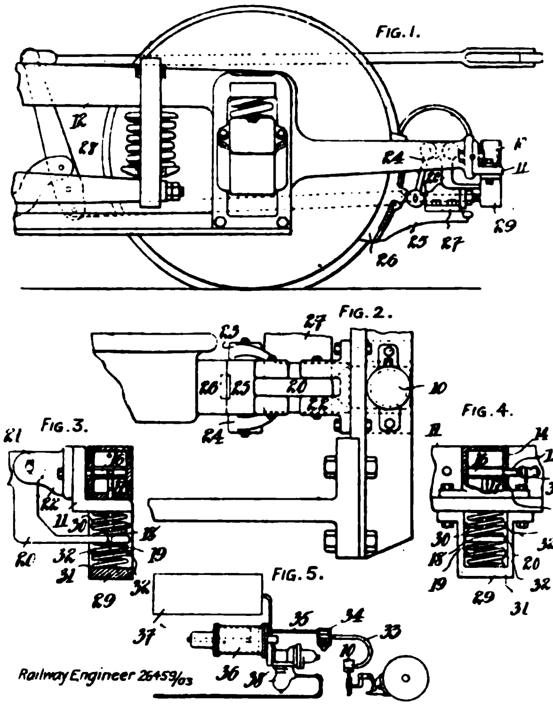
The frame is constructed with a view to lightness, a channel steel section being used for the whole of the outside of the frame. Channel section is also used to carry the buffers of a much lighter pattern than usual. A lighter channel section is used for the cross members of the frame parallel with the axles. Stay rods on channel steel supports are used to prevent sag in the middle of the frame. As few holes as possible are made in the lower or horizontal web of the main frame channel, or solebar. The scroll irons, horn plates and other parts are bolted to additional side channels which carry the buffers. The buffers are of a very light pattern provided with coiled springs, and attached to the ends of the additional channels which are carried down below the engine cross channels and continued along the car at each end below and parallel with the outside frame and are bolted to the cross pieces. One central or almost central channel member connects the two nearest cross channels at each end. Where cross channels are not employed, ash joists are carried across the frame, and the floor of the car is bolted to the ash cross pieces as also to the cross channels. To the cross channels at one end the engines of six cylinders are bolted. The cylinders are preferably arranged with the crankshaft lengthwise with the car, and the side twin cylinder engine drives the shaft of the 4-cylindered engine parallel with it by means of a chain and chain wheels through the intermediary of a friction clutch. One fly wheel only is required for the four cylinders, and this may be placed in the centre. The friction clutch for the main drive is placed between the gear box and the four cylindered engine with a universal joint between the clutch and the gear box to permit of a slight bending of the frame. In this way the engine or pair of cylinders may be disconnected and started and run or stopped independently of the four cylinders. The bevel wheel at the end of this shaft is within the gear box and is preferably always in gear with two other bevel gear wheels both of which are free on the shaft and which are operated by a jaw clutch sliding between them on a square part of the shaft. On either side of the two bevel gear wheels is a sleeve each carrying two driving pinions, which sleeves are connected together by a rod, and slide together from one side of the box to the other to change the four speeds. From the lower and slower of the two shafts on one end of gear box a sprocket wheel is fitted driving a chain connected to the chain wheel on the main or driving axle of the car, or the large chain wheel may be bolted to one wheel of the pair of car driving wheels. Four bearings are provided on each shaft. A cab or covered space is provided for the driver at each end of the car. A



lever to reverse by change of the bevel gear, a lever for operating the change speed gear, and a brake lever, are fitted at both ends of the car. The first movement of the brake lever takes off the clutch. The continuance of the movement puts on the brake. The four rods for operating: 1, the reverse; 2, the change speed; 3, the brakes, and 4 the clutch on the side engine, are all carried from end to end of the car. Instead of the usual pattern of railway or tramway axle box, a phosphor bronze casting somewhat similar to those used on road vehicle axles is employed, but this is stationary and is bolted to the springs. This axle box is also provided with square slots within which the horn plates fit, and upon which it may slide up and down with the movement of the springs. The horn plate side stays are preferably of angle section to prevent their bending to side strains. As in this case the axle rotates, the oil grooves are cut in the stationary phosphor bronze axle box. *(Accepted 20th October, 1904.)*

Air Brakes. 26459. 3rd December, 1903. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London (a communication from the General Electric Co. of Schenectady, New York, U.S.A.).

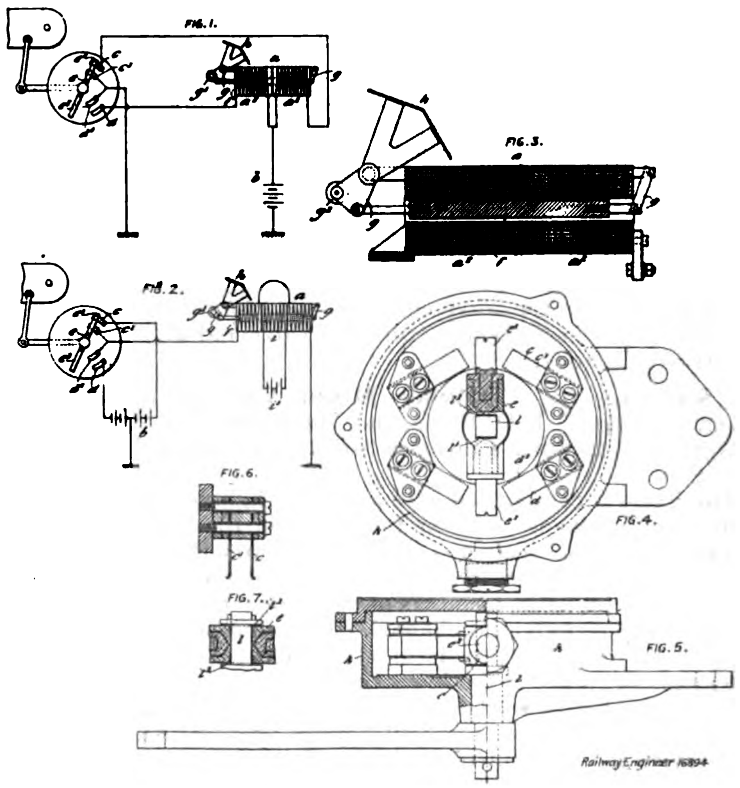
According to this invention the reduction of brake-shoe pressure to avoid sliding of the wheels when making a stop is made directly dependent upon the friction between the brake-shoes and the wheels. The valve-casing 10 of an exhaust controlling valve is provided with an inlet or supply port 13 and exhaust ports 14, 15, and a slide valve 16 which normally closes the inlet port 13. The stem 17 of the slide valve is movably secured at its lower end by means of pins 18 and 19 to the lower horizontal portion of a Z-shaped lever 20 pivotally secured near its upper end at the point 21 to a casting 22, which is bolted to the vertical portion of the cross-bar 11 in proximity to the valve-casing 10. This Z-shaped lever together with the downwardly-extending links 23 and 24 pivotally secured to its upper and inner end connect the valve piston and the brake-shoe, the lower end of the links 23, 24, being secured to the brake-shoe head 25. A stirrup 29 is secured to the cross-bar 11 directly beneath the valve-casing 10 and serves both as a guide for the lower horizontal portion



of the lever 20 and as a casing for coiled springs 30, 31, which bear upon opposite sides of this portion of the lever 20 and normally maintain it and the valve 16 in a central position. Suitable stops 32 on the inner walls of the stirrup limit the movements of the lever 20. The supply port 13 of the valve-casing 10 is in direct communication through a flexible connection 33 with a pressure-retaining valve 34 and the latter is connected in turn by a pipe 35 with the upper end of the brake cylinder 36. When making a stop, as soon as the speed of the train decreases by reason of the brake action, the friction between the shoe 26 and its wheel will increase, and when it has increased sufficiently to drag the shoe in the direction of rotation of the wheel, in opposition to the restraining action of the springs 30 and 31, the valve 16 will uncover the inlet port and establish communication between it and one of the exhaust ports, 14, 15, according to the direction of rotation of the wheel, and air will then escape from the brake-cylinder and thereby through the agency of the brake-rigging correspondingly reduce the brake-shoe pressure. As soon as this brake-shoe pressure falls off so that the friction between the brake-shoe and its wheel is insufficient to pull the brake-shoe around in opposition to the springs 30 and 31, the parts will be returned to normal position through the action of the springs and inlet port 13 of the controlling-valve closed. Upon further reductions in the speed of the train, the same operation of the parts will be repeated intermittently until the pressure in the brake-cylinder has fallen off sufficiently to allow the retaining valve 34 to cut off communication between the brake-cylinder and the controlling-valve and thereby render the controlling-valve inoperative. The retaining valve should be adjusted so as to bring this about when the pressure in the brake-cylinder has fallen sufficiently to render further reductions unnecessary. *(Accepted 20th October, 1904.)*

Indicator for Points, Signals, &c. 16894. 2nd August, 1904. Siemens Bros. & Co., Ltd., 12, Queen Anne's Gate, Westminster, and L. M. G. Ferreira, Lyncroft Gardens, Ealing.

Relates to electrical apparatus for indicating at a distance the position of signals, points, or other gear. A switch, mechanically operated by the point or signal, controls an electric circuit, in which is concluded an electro-magnet arranged to operate a disc or other indicator. In one arrangement with a double metallic circuit and earth return, one end of the solenoid *a* is electrically connected with one of a pair of insulated switch contacts $c\ c^1$ and the other end with one of a similar pair of switch contacts $d\ d^1$ the other members of each pair of contacts being connected with each other and with earth. The switch contact arm *e* is arranged to be moved through suitable linkage by the signal or points which in



working occupies one of two positions so as to connect either the contacts $c\ c^1$ or the contacts $d\ d^1$ according to the position of the gear. When the former are connected a current passes through the part a^1 of the coil *a*, and when the contacts $d\ d^1$ are connected, a current passes through the part a^2 of the coil *a*. A soft iron core *f* is suitably suspended as by links *g* from the frame of the solenoid, so that when there is no current in the solenoid it hangs centrally therein. According as a current passes through the part a^1, or the part a^2 of the solenoid, the core *f* is displaced longitudinally in one direction or the other to a definite position in either case, and the indicator disc or flag *h*, which is linked to the solenoid core *f*, and may consist of an extension of one of the supporting links *g* balanced by a suitable counterpoise g^1, is brought to occupy one of two corresponding positions. In the arrangement of fig. 2, the core *f* is polarized either by being made of permanently magnetised steel or as shown in the diagram, by means of an auxiliary coil *i* and auxiliary battery i^1, the main

battery b being in this case placed at the switch end of the circuit and having one pole connected with one of the switch contacts c c^1 and the other pole connected with one of the contacts d d^1, the other members of the two pairs of contacts being connected with each other and through line to one end of the solenoid coil a. The other end of the solenoid a and an intermediate point of the main battery b are connected with earth. According as the switch arm e is moved to connect the contacts c c^1, or the contacts d d^1 one pole or other of the battery b is connected with line and the polarized core f is attracted or repelled in one direction or the other according to the polarity of the line current. In the form of switch illustrated, four sets of spring contacts are shown, the second two sets being for the purpose of operating a second indicator electro-magnet or other apparatus as desired. The switch arm e is mounted on the spindle l in such manner that while it is constrained to rotate it is free to slide along the spindle and also to tilt, and this flexibility of mounting ensures good connection between the switch arm ends e^1 e^2 and the sets of contacts with which they may be simultaneously in engagement. *(Accepted 29th September, 1904.)*

SPECIFICATIONS PUBLISHED.

1903.

19022. Cars for single rail elevated railways; Behr. 22551. Electric motors and controlling devices for use in the electrical propulsion of vehicles or trains of vehicles; Raworth. 22757. Label holders for wagons; Farr and Blower. 22758. Voltage regulated electric system for lighting carriages, ventilating, heating, &c.; Dalziel. 22914. Emergency brakes; Carolan (General Electric Co.). 23442. Railway or tramway motor car; Roots and Roots (Oil Motor and Motor Car, Ltd.) 23471. Train tablets or staffs and crossing permits; Higley (Higley). 24281. Couplings; Darwin and Sharp. 24739. Rails; Hadfield. 24746. Rails for tramways and railways; Winterburn. 24796. Motor controllers and emergency brakes for railway and tramway vehicles; British Thomson-Houston Co., Ltd. (General Electric Co.). 25281. Points and crossings; Hadfield. 25362. Brake apparatus; Johnson. 25410. Couplings for colliery trams or corves; Charles. 25498. Fastenings for wagon doors; Evans. 25527. Electric train control systems; British Thomson-Houston Co., Ltd (General Electric Co.). 25718. Door fastening apparatus; Macdonald. 25856. Air brake systems; British Thomson-Houston Co., Ltd. (General Electric Co.). 25991. Central buffer and draw gear apparatus; Spencer. 26438. Simultaneously locking or unlocking carriage doors in trains; Armitage and Senior. 26459. Brakes; British Thomson-Houston Co., Ltd. (General Electric Co.). 26463. Air brakes; British Thomson-Houston Co., Ltd. (General Electric Co.). 26483. Manufacture of wheels and wheel centres; John Baker & Co. (Rotherham), Ltd., and Baker. 26721. Speed and mileage recorders for tram cars; Hartley and Canova. 26752. Joints for tramway rails; Trippett. 26916 Means for advertising on and indicating the routes of electric tramcars and other electric vehicles; Walkden. 27040. Apparatus for twisting rails; Whale. 27106. Buffers for the conversion of dead buffer vehicles; Turton. 27349. Vacuum brakes; Westinghouse Brake Co., Ltd., and Cloud. 27811. Pivot and side bearers for bogie trucks; Hoffman Manufacturing Co., Ltd., and Mair. 27813. Automatic fluid pressure brake apparatus; Westinghouse Brake Co., Ltd., and Cloud. 27844. Preventing jambing of movable tongues in tramway points; Cooley.

1904.

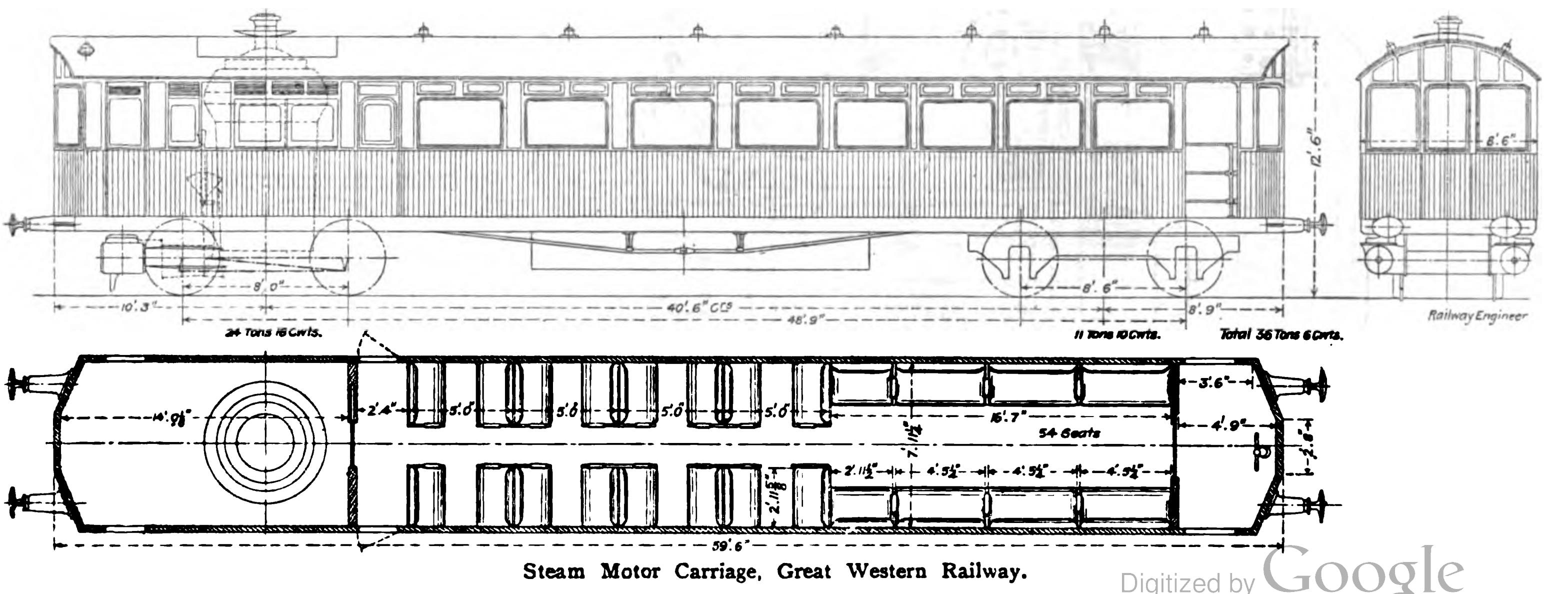
111. Hinges for carriage doors; Goodman. 1637. Apparatus for stopping engines and trains independently of the drivers; Privat. 2899. Electrical signalling systems; Struble. 5398. Rail joint shoes and clamps; Anderson. 8745. Trolley pulleys of electric tramcars; Binns. 9340. Means for carrying overhead trolley wires; Morris. 9586. Signalling apparatus; Lake (Hall Signal Co.). 10153. Railway systems and means for handling passenger traffic; Wellman. 10276. Electric block signalling systems; Silvene. 13719. Rails; Allendorph. 14060. Conductor and collector devices for electric railways and tramways; Boezano. 15264. Life guards for tramcars; Bowker. 15381. Air brakes; Howorth (Compagnie Internationale de Freinage, System Luyers, Soc. Anon.). 16021. Chair keys; Colquhoun. 16894. Apparatus for electrically indicating the position of signals, points, &c.; Siemens Bros. & Co., Ltd., and Ferreira. 17046 Electric traction system; Marshall. 17112. Apparatus for regulating the action of air brakes; Siemens & Halske Akt-Ges. 17281. Valves for air brakes; Allison (Levy). 17567. Couplings; Fried Krupp Akt-Ges. 18130. Device for lubricating rails; Fallnicht. 18136. Rail joint; Fetzer and Czaykowski. 18141. Electric block systems; Robinson. 18265. Railway cars; Sullivan & Renshaw. 18344. Apparatus for producing air pressure and vacuum for operating brakes; Edwards (Waggon und Maschinfabrk, A. G. vorm Busch). 18418. Car couplings; Tomlinson. 18656. Fixing tyres to wheel centres; Stapf. 18949 Safety guard for conductors of electric railways; Sale. 19245. Automatic signals for electric railways or tramways; Wilson & Marshall. 19410. Dumping cars; Peiler. 19465. Crossings of tramways; Kombst. 19581. Bogie frames for rolling stock; Schuler.

Steam Motor Carriages*: Great Western Railway.

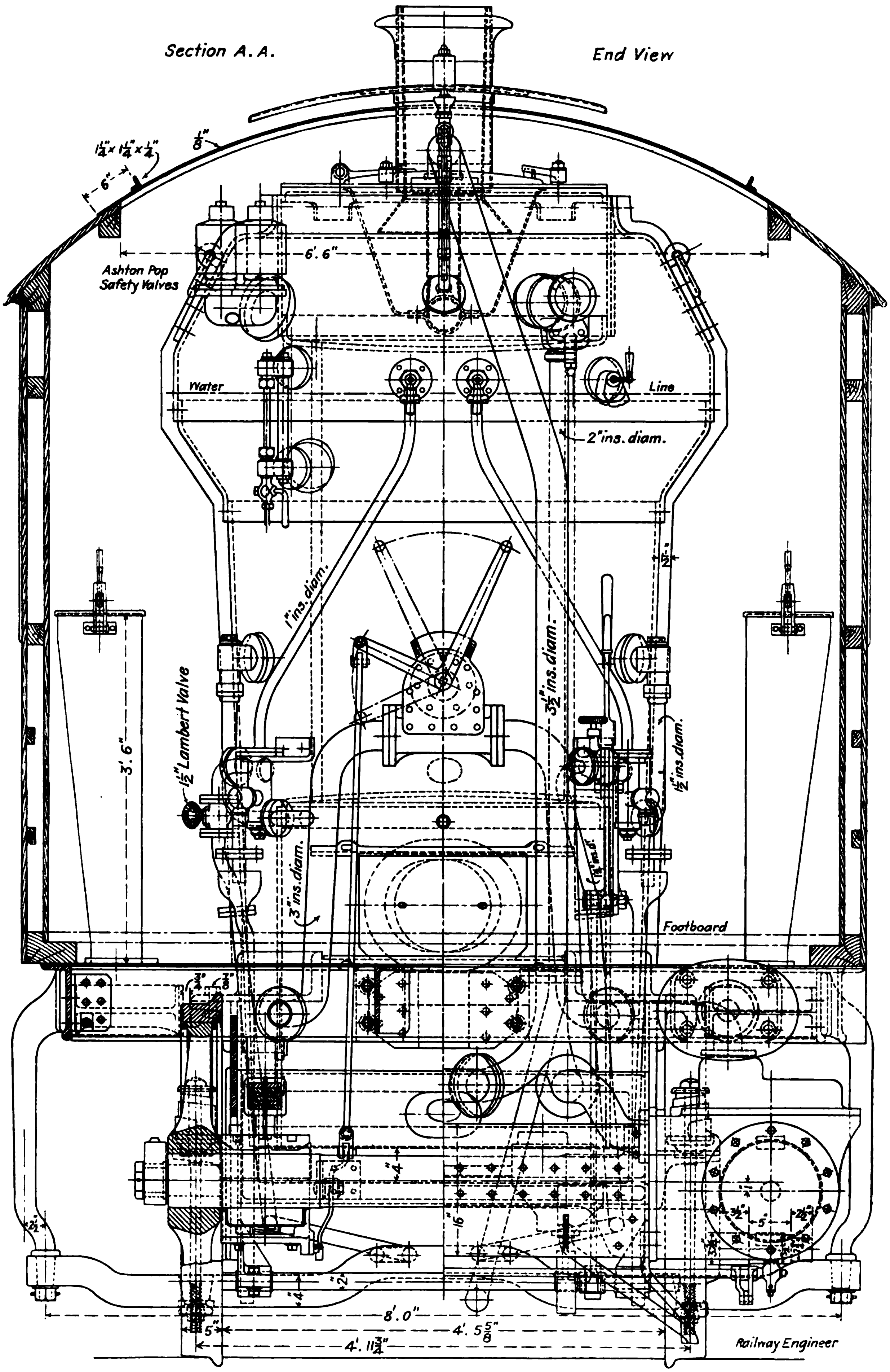
In our issue for December, 1903, we published a description of the first of the Steam Motor Carriages which Mr. G. J. Churchward, M.Inst.C.E., designed and built at the company's works at Swindon for the Great Western R. The success in traffic of these vehicles was so great, that since that time a considerable number of them have been built to the annexed drawings, which, by Mr. Churchward's courtesy, we are able to publish herewith. And several other railway companies, while modifying the arrangement of the carriage body to suit their own local traffic requirements, have more or less completely imitated the engine, boiler, bogies, underframe, and method of suspension, in fact all the salient features of the design.

The boiler, of which we give a detail drawing, rests directly on the top of the side frames of the engine bogie by means of angle-iron brackets riveted to the shell. It is fitted with 477 tubes $1\frac{1}{8}$ ins. diam., and which give a heating surface of 625·58 sq. ft., the fire-box produces 46·75 sq. ft., making a

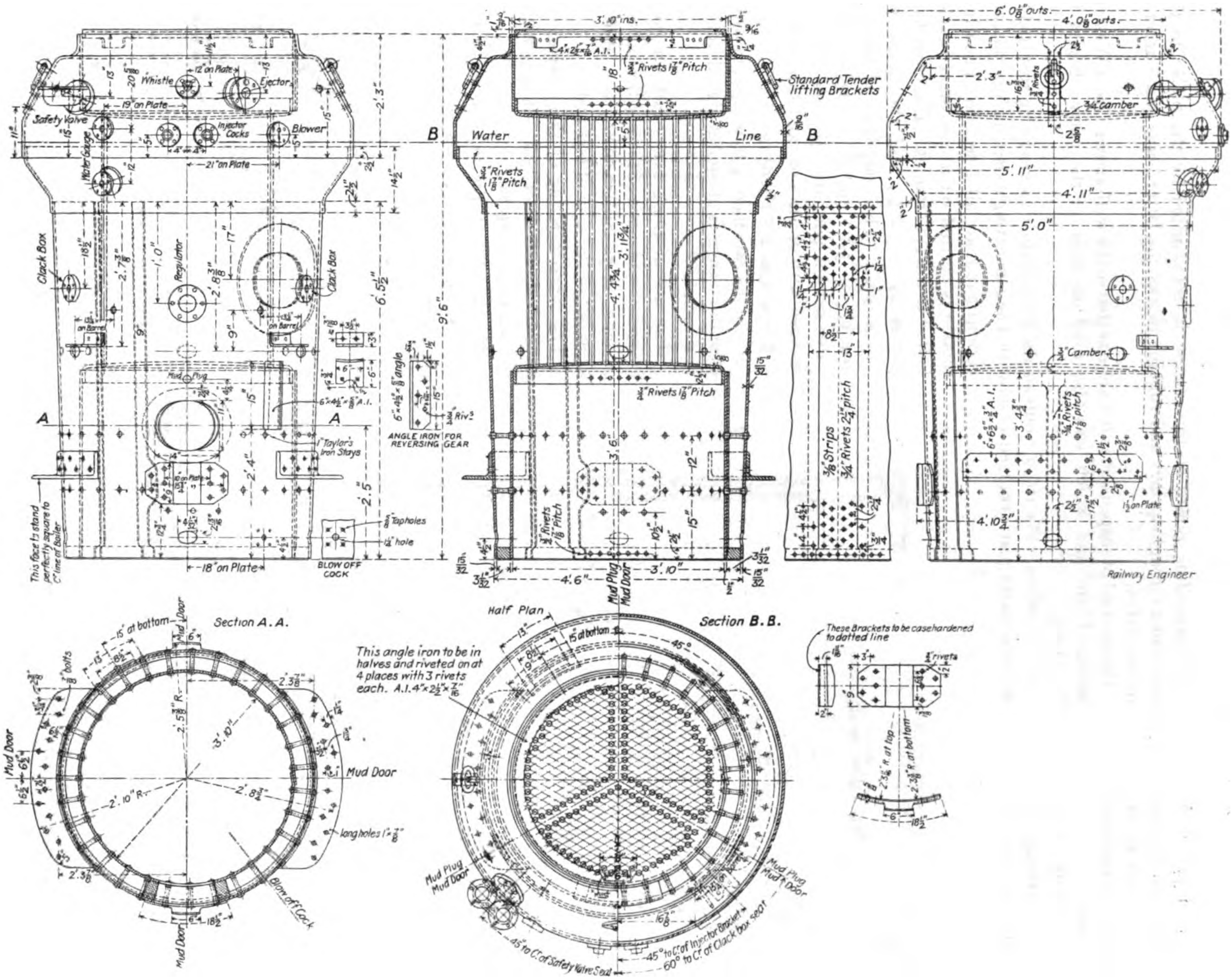
* For drawings of the Taff Vale R. steam motor carriages, see the *Railway Engineer* for November, 1904.



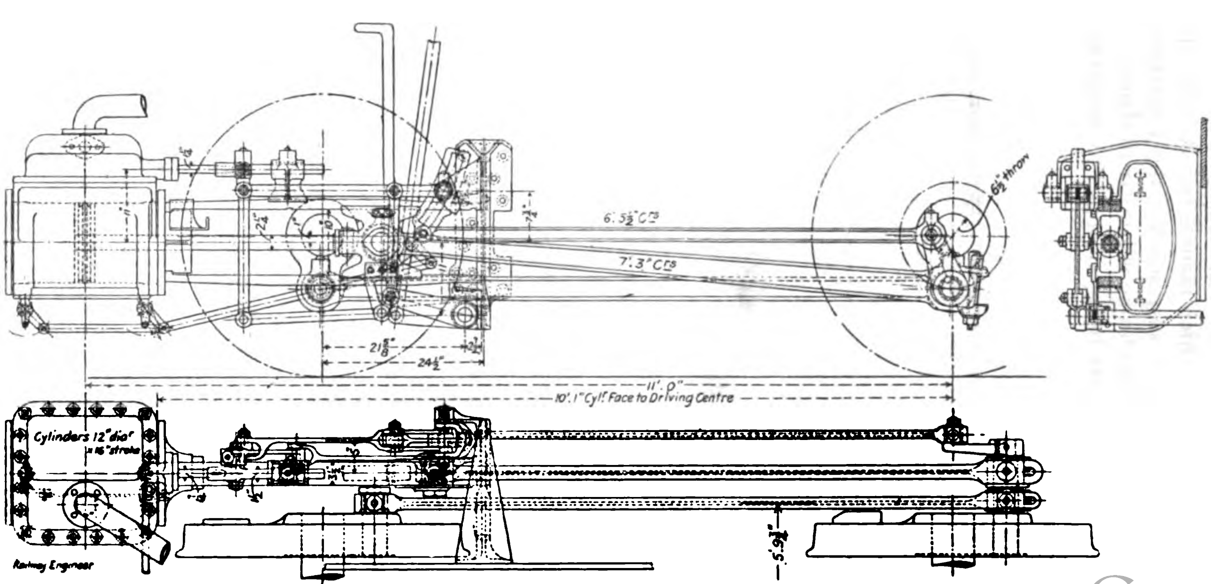
Steam Motor Carriage, Great Western Railway.



Steam Motor Carriage, Great Western Railway.



Boiler, Steam Motor Carriage, Great Western Railway.



General Arrangement of Motion, Steam Motor Carriage, Great Western Railway.

total heating surface of 672·33 sq. ft. The grate area is 11·54 sq. ft. The flue area 2·18 sq. ft. The area at the water line is 24·22 sq. ft., and the steam space 21·90 cubic ft. The working pressure is 160 lbs. per sq. in., with a factor of safety of 4·8. The end view shows clearly the arrangement of the mountings, which include two Ashton "pop" safety valves.

The water tank is suspended to the underframe, and has a capacity of 450 gallons. The underframe is similar to that of a Great Western carriage, the transverse members being arranged to allow the boiler to stand between them.

The propelling power of the engine is transmitted by the boiler] to the underframe through springs and rubbing blocks, the latter being case-hardened on their faces.

The method of suspension is the same as that of the well-known Great Western carriage bogie, and which was also used on some of the engine bogies by Mr. Dean.

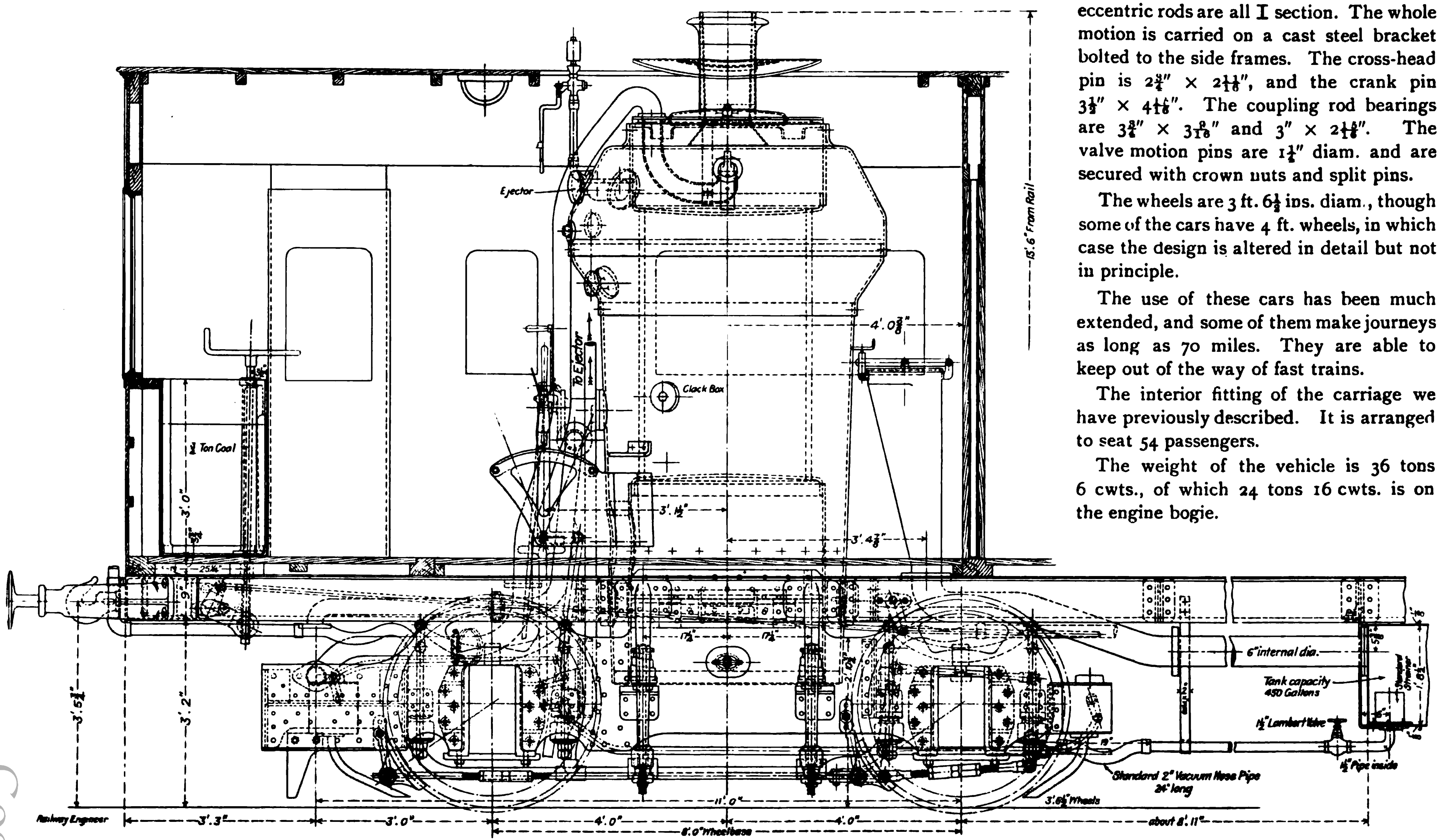
The cylinders, 12″ × 16″, are outside the frames, their valves being operated by the Walschaert gear, arranged as shown. The connecting rods, coupling rods, and eccentric rods are all I section. The whole motion is carried on a cast steel bracket bolted to the side frames. The cross-head pin is 2¾″ × 2$\frac{11}{16}$″, and the crank pin 3½″ × 4$\frac{15}{16}$″. The coupling rod bearings are 3¾″ × 3$\frac{9}{16}$″ and 3″ × 2$\frac{15}{16}$″. The valve motion pins are 1½″ diam. and are secured with crown nuts and split pins.

The wheels are 3 ft. 6½ ins. diam., though some of the cars have 4 ft. wheels, in which case the design is altered in detail but not in principle.

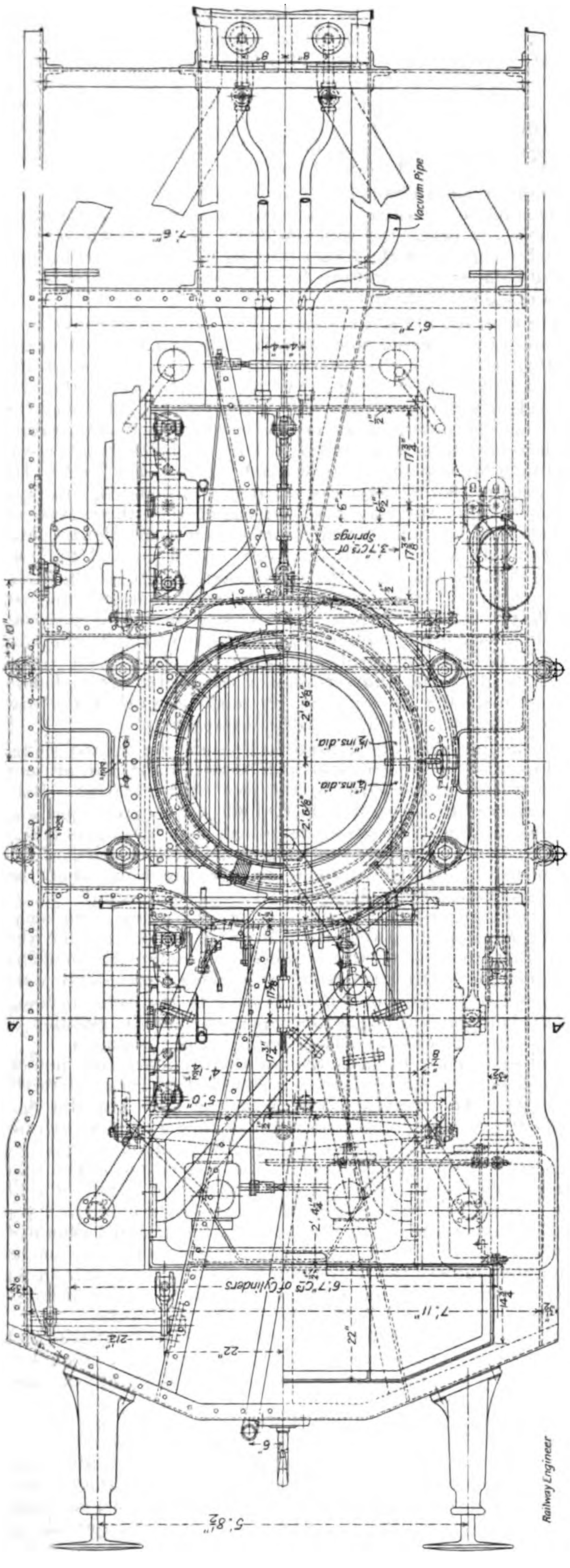
The use of these cars has been much extended, and some of them make journeys as long as 70 miles. They are able to keep out of the way of fast trains.

The interior fitting of the carriage we have previously described. It is arranged to seat 54 passengers.

The weight of the vehicle is 36 tons 6 cwts., of which 24 tons 16 cwts. is on the engine bogie.



Steam Motor Carriage, Great Western Railway.



Steam Motor Carriage, Great Western Railway.

Official Reports on Recent Accidents.

Near CARDIFF STATION, G.W.R., *on the 15th July. Lt.-Col. P. G. von Donop, R.E., reports :—*

That a Taff Vale R. passenger train—11 vehicles—from Cardiff to Penarth, ran into, at a speed of about 10 miles an hour, the end of a Barry R. mineral train of 42 wagons, standing on the up Riverside line foul of the junction : 7 passengers complained of injury : the brake van and rear wagon were wrecked.

The up and down Riverside lines are on the south side of the main lines and almost parallel to them. About 250 yards to the west of Cardiff Station and on the north side of the main lines there is a signal-box known as the Penarth Junction signal-box. Opposite this box the space between the main lines and the Riverside lines is about 40 feet in width, and here is situated a double junction between these two sets of lines ; the points and signals of this double junction are worked from the Junction signal-box, and the facing connections are on the down main and up Riverside lines respectively. The facing connection on the up Riverside line is situated 160 yards to the west of the Junction signal-box, and the up home signals for the Riverside line protecting this connection are situated a few yards west of the points. There is also on the Riverside lines a short distance to the east of the double junction a cross-over road, the points and signals of which are also worked from the junction signal-box. The next signal-box in the down direction on the Riverside branch is the Penarth Curve Middle box, situated about 480 yards to the west of the Junction signal-box. Near this signal-box there are sidings on the north side of the Riverside lines, and at a short distance to the east of the box there is a trailing connection on the up Riverside lines leading from those sidings. There is also on the west side of this box a second cross-over road between the up and down Riverside lines.

The B. R. special mineral train had been marshalled on the sidings near the Middle Junction signal-box, and it was due to go away to Penarth on the down Riverside line. It was drawn out of the sidings on to the up Riverside line and stopped between the Middle Junction and the Junction signal-boxes in order to allow the engine to run round it. The brake van was next the engine, and the guard had, consequently, to ride on the buffer of the rear wagon, which cannot be regarded as either a safe or satisfactory arrangement.

This train had been duly offered to and accepted by signalman Johns, who was on duty in the Junction signal-box, and he had lowered for it the Riverside line up home signal. Driver Heard, who was in charge of the engine of the mineral train, accordingly ran a short distance past that signal. His engine was then uncoupled by number-taker Ridd, and under Ridd's directions Heard ran his engine round his train by means of the cross over roads and the down line. Meanwhile the train was left standing on the up Riverside line, with its leading vehicle, which was the brake van, foul of the double junction, and with no light on its leading end.

As soon as signalman Johns received intimation from the Middle box that the engine was clear of the down line he offered the signalman in that box the Taff Vale down passenger train, which was then standing in Cardiff Station, and which was due to run to Penarth on the down Riverside line. It was at once accepted, and Johns lowered the signals for it to run through the connection leading from the down main line to the down Riverside line. It did so and came into collision with the brake van.

There appears to have been no necessity for signalman Johns to have allowed the mineral train to have run past the Riverside line up home signal and to have thus fouled the double junction. His explanation is that he thought he might save time thereby, and this might possibly have been the case. It was clearly incumbent on him, before allowing the junction to be made use of, to have ascertained whether the mineral train was clear of it. He did not, however, take any steps in the matter but took it for granted that the

junction was clear. The night appears to have been dark and there were certainly no lights on the van, but the latter was not more there 136 yards from the signal-box, and there was a yard lamp 27 yards from the van. Johns must be held largely responsible for this accident.

The shunting, though it took place on lines belonging to the Great Western R. Co., was, except as regards the signalmen, carried out entirely by the servants of the Barry R. Co., and this stated to have been the usual custom at this spot with similar is operations for some years past. The B. R. Co. appears to have acquiesced in this arrangement, and, though on this occasion the G. W. R. foreman shunter was close at hand whilst the shunting was being carried out, no application was made to him for any assistance.

Number-taker Ridd took entire charge of the shunting movement, and that with loaded trains it is customary for him to do so. He uncoupled the engine and gave the driver instructions to move forward to the cross-over road, and he accompanied the engine until it reached the rear end of the train. These movements Ridd carried out without receiving any signals or instructions from the guard. Ridd admits that he left the front of the train standing foul of the junction, but he did not consider that there was any harm in doing so; he also admits that he knew that he was leaving the train standing there with no light of any sort on its leading end, but he considered that that was a matter which it was the guard's duty to see after, and he himself took no steps in the matter. It seems strange to find a number-taker taking charge of a shunting movement, and from the way in which Ridd carried it out it seems doubtful whether he was qualified for the work.

Guard Mogford remained at the rear end of the train awaiting the arrival there of the engine. He states that he considered that he was in charge of the shunting movement, and, as there was only a number-taker to assist him, it was his duty to have taken charge of it. But, beyond attempting to give the driver a signal to stop Mogford did not take any further part in carrying it out. He certainly looked after the protection of the rear of the train, but for the safety of the front of it and for the provision of a light on it he depended entirely on Ridd, though he admits that he had never previously known a light to be provided by a number-taker.

It seems strange that neither the driver nor the fireman of the Taff Vale train should have seen anything of the brake-van of the mineral train before actually coming into contact with it. Driver King's view was interrupted by the front of his engine, but there appears to be no excuse for fireman Hall, who was on the right side.

*

At East Linton Station, N. B. R., *on the 12th September. Major J. W. Pringle reports that :—*

A goods train standing in a siding was run into by the 2.8 p.m. down express from Berwick, consisting of 4-coupled bogie engine, tender, eight 8-wheeled and two 6-wheeled vehicles, fitted throughout with the Westinghouse automatic brake on 72 out of the 76 coach wheels.

Through East Linton Station the line is double, the southern rails are used for down traffic.

The station signal cabin is on the north side of the railway, adjoining the west end of the up platform. Immediately in front of it there are facing points leading to a down loop siding, and which are fitted with all the necessary safety requirements, viz., lock, locking bar, and detectors.

There is the usual interlocking in the signal lever frame, by which neither of the two levers, actuating respectively the down home and down starting signals, can be pulled over, unless the down loop facing points lever is in its normal position, *i.e.*, back in the frame, and the facing points have been locked for the down main line by drawing over the locking lever. The actual length of rodding between the facing point lever and the connecting rod of the points is 30 ft. 10 ins. The rodding is of wrought iron, channel section, 1⅝" by 1¼" by ¼", weighing 9 lbs. per yard, carried by three bell cranks and one traversing cast steel roller, at intervals varying from 4 ft. 5 in. to 7 ft. 8 ins.

At 2.56 p.m. the down goods train was placed in the down loop siding. At 3.7 p.m. the down express was offered to, and accepted by, signalman Gillies. At 3.11 p.m. he received the "Entering section" signal for the express from Beltingford, about 3½ miles to the east of East Linton.

Gillies then attempted to lower the down line signals for the express by working his levers, but succeeded in drawing off only the outer and inner advance starting signals. He could not pull over the levers working the down starting and down home signals, and the down distant signal consequently also remained at danger.

He went out of his cabin, crossed the line, and endeavoured, by an examination of the down starting signal attachments, and afterwards of the interlocking under the floor of the signal cabin, to discover why the levers working the two named signals were immovable. He failed to discover the reason, and asserts that he then returned to the cabin, replaced the lever working the lock on the facing points lever, and then for a second time worked the lock bar lever. He then again tried to lower the starting and home signals, but again failed. He was now persuaded that there was no reason why he should not be able to lower his signals, and accordingly went out of his cabin, again crossed the two pairs of lines, and lifted the counterweight arm of the starting signal. The semaphore arm was thus lowered to "safety," and Gillies pinned or wedged it in this position. He then instructed surfaceman Alexander to run to the east end of the down platform, and lower the down home signal arm, by lifting the counterweight. Alexander succeeded in doing this, after having first, by mistake, worked the disc signal, instead of the home signal semaphore.

In the meantime the express had passed the distant signal and found it at danger, and had been brought almost to a standstill about 120 yards to the east of the station. Bell, the driver of the express, whistled for the home signal and seeing it lowered, as above described, gave his engine steam and passed the home and starting signals. The speed of the train had increased to about 20 miles an hour when the express entered the siding, and the collision occurred.

Having regard to the position of the points, the short length of rodding between the cabin and the points, and the fact that the points were immediately after the collision found to be undamaged and in working order, and were reversed by signalman Gillies himself in the ordinary way, no explanation will justify the assertion that the position of the point lever was at variance with that of the points.

Gillies failed to examine the position of the facing points, though he twice passed within a few feet of them in broad daylight. He thereby broke Rule 60 (*a*). He did not immediately report to the station-master or agent, in accordance with the Rule 57, that the signalling apparatus was not in order. He must have come to the conclusion, either that the interlocking of the lever-frame was out of order, or that the signals had become defective, and should therefore have acted in accordance with Rules 73 (*a*), (*b*), (*c*), and obtained the services of a hand signalman. Instead of doing so, he took upon himself the responsibility of lowering signals in an illegal manner, and thus set at nought all the rules and interlocking arrangements devised for the safety of traffic.

Gillies has been employed for two years as signalman, and had been over 9 hours on duty. He bears a good character, but there is no excuse for such a wholesale disregard of rules and safety appliances.

That the collision was only a slight one is due to the fact that the distant signal was kept at danger by the interlocking, and was too far away (980 yds.) to be tampered with, and also to the promptness with which driver Bell of the express train recognized his position and applied his brakes, and who is to be commended for his alertness and promptitude of action.

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The subscription to *The Railway Engineer* is 14s. (payable in advance), post free to any country in the world.

THE Railway Engineer

Volume XXVI., No. 2. *FEBRUARY*, 1905.

Contents, February, 1905.

In our last issue we mentioned that as a result of Mr. Robertson's report upon the Indian railways, the Secretary of State for India had decided to appoint a Board of Supervision, consisting of a Chairman and two members. And we also mentioned that Mr. F. R. Upcott, C.S.I., and Mr. T. R. Wynne, C.S.I., had been appointed members of it, the former to be Chairman. We are now informed that **Mr. Walter H. Wood**, general manager of the Hull, Barnsley, and W. R. Junction R., has accepted the third seat.

Mr. Wood was formerly goods manager, and succeeded Mr. Vincent Hill in 1901. The appointment is for five years, and the salary £3,000 per annum. The position was, we understand, offered to and declined by Mr. John Davies, general manager of the Midland and South Western Junction R.

Mr. R. Anderson, C.M.G., who as chief engineer superintended the construction of the Uganda R. in East Africa, has been appointed Chief Engineer for Construction of the Argentine Great Western R., and is now on his way to Mendoza.

Mr. John Guirey, Belfast, has been appointed one of the Auditors of the Donegal R. in succession to Mr. Walter Bailey, now chief accountant of the Midland R.

Mr. H. G. Lewin, assistant district superintendent at Sunderland, North Eastern R., has been appointed District Superintendent at York.

Mr. John Elliott, assistant (out-door) superintendent of the line Midland R., has been appointed Superintendent of the Line in succession to Mr. T. Eaton, who has retired.

Mr. John Robinson, chief clerk goods manager's office Glasgow and South Western R., has been appointed Chief Goods Manager in succession to **Mr. Henry Evans**, who, as noted in our last issue, has been appointed Chief Goods Manager of the Midland R.

Mr. Joseph Carter has been appointed Secretary of the Metropolitan District R., in succession to **Mr. Wm. Jones**, who has retired.

Mr. Henry Bell has been elected Chairman of the Buenos Ayres Western R., in succession to **Mr. Hy. G. Anderson**, who has retired from the Board.

The Rt. Hon. Lord George Hamilton, M.P., and **Mr. J. Clifton Robinson** have been elected Directors of the Underground Electric Railways Co. of London.

The Rt. Hon. J. L. Wharton, M.P., has been elected Deputy Chairman of the North Eastern R., in succession to the late Sir I. Lothian Bell, Bart.

Mr. J. Morris, superintendent of the line Great Western R., **Mr. W. J. Grinling**, chief traffic manager Great Northern R., and **Mr. T. Eaton**, late superintendent of the line Midland R., have had the Order of Padroeira do Reino conferred upon them by the King of Portugal, in recognition of the excellent travelling arrangements in connection with his recent visit to this country.

Mr. H. G. Drury, late superintendent of the line Great Eastern R., has had the Royal Victorian Order (4th Class) conferred upon him by the King, in recognition of the services rendered in connection with the Royal journeys.

Mr. F. G. Randall, station-master at Liverpool Street, and **Mr. H. J. Prytherch**, chief clerk of the claims department Great Eastern R., have been appointed Chief Assistants to the superintendent of the line for the out-door and in-door departments respectively.

Mr. Jas. C. Inglis, general manager of the Great Western R., has been nominated as one of the representatives of the Institution of Civil Engineers on the Engineering Standards Committee in the place of the late **Mr. J. A. McDonald**, engineer-in-chief of the Midland R.

With great regret we record the death of **Mr. Alexander McDonnell**, formerly locomotive superintendent of the Great Southern and Western R. of Ireland, and also of the North Eastern R. He died quite unexpectedly in December last. He was on his way to Ireland when he was taken ill at Rugby; he proceeded as far as Holyhead, where a few hours afterwards he expired, mourned and esteemed by all who knew him. He was 75 years of age.

Rating Appeals by the Great Northern Railway.

Mr. A. J. Brickwell, surveyor to the Great Northern R., is to be congratulated upon the successful results of his crusade against unjust assessments of his company's property. We recently drew attention to one of his victories, and we now have to record another, viz., that against the Assessment Committee of the Hunslet (Leeds) Union, who recently raised the assessment of the company's property in Middleton from £2,737 to £3,100, in respect of 2 m. 17 ch. of the main line to Leeds and the Hunslet and Tingley branches. The West Riding Justices at the Quarter Sessions at Leeds reduced the assessment to £1,414 and ordered the Committee to pay the costs, which for some reason or other in rating cases are simply terrifying.

The above case should have an encouraging and stimulating effect not only on Mr. Brickwell, but on all other railway surveyors.

Cost and Performance of Locomotives in West Australia.

The official cost of working the principal classes of locomotives on the West Australian Government Railways for twelve 4-weekly periods, from 1st July, 1902, to 31st May, 1903, and from 1st June, 1903, to 1st May, 1904, is shown in the following table:—

Class.	Where built.	Date placed on line.	Average engine mileage per engine per four weeks. 1903.	1904.	Tons capable of hauling over ruling grade.	Average cost per Engine mile. 1903.	Engine mile. 1904.	Train mile. 1905.	Train mile. 1904.	Average cost per train mile per 100 tons hauling power. 1903.	1904.	Gradients: Eastern 1 in 25; Northern 1 in 30; Great Southern 1 in 55; Eastern Goldfields 1 in 60; South Western 1 in 40; Collie 1 in 42; Donnybrook 1 in 40.
						d.	d.	d.	d.	d.	d.	
C	America	1902	2.274	1.770	184	11·78	11·19	13·08	11·71	7·11	6·36	Eastern, Northern, and Gt. Southern
E	Great Britain ..	1902	1.632	2.061	208	14·48	10·04	15·32	10·80	7·37	5·19	Eastern and Eastern Goldfields
Ec	America	1901	2.746	1.316	208	10·16	13·15	12·91	14·41	6·21	6·92	Eastern Goldfields
F	Great Britain ..	1902	1.288	1.265	275	17·07	16·71	18·87	18·89	6·86	6·83	Eastern
G	Gt. Brit. Sth. Aust.	1889 to 1899	1.230	863	120	14·44	13·21	22·26	23·03	18·55	19·19	Eastern, E. Gldfds., Sth. West. & Nthn.
K	Great Britain ..	1893 to 1898	1.179	1.161	208	21·08	18·56	24·15	21·21	11·61	10·19	Eastn., Collie, & Donnybrook-Bdgtn.
N	Great Britain ..	1896 to 1901	1.690	1.656	120	13·54	13·62	14·55	14·49	12·12	12·07	Eastern and Eastern Goldfields
O	Great Britain ..	1895 to 1898	1.703	1.267	184	15·33	13·65	17·80	15·45	9·67	8·39	Eastern, E. Gldfds., Sth. West. & Nthn.
P	South Australia ..	1896	1.304	916	104	16·05	11·37	25·77	12·51	24·77	12·03	South Western
R	Great Britain ..	1897 to 1899	2.608	1.716	120	17·83	10·68	17·83	11·83	14·86	9·85	Northern, Eastn., & Eastn. Goldfields
T	Great Britain ..	1889	2.406	2.067	108	9·87	8·81	9·87	9·25	9·14	8·50	Eastern, Gt. Southn., & Sth. Western

The cost prices of the engines (above referred to) delivered in the Colony are shown in the table below:—

Class.	Description.	Stock on 30th June, 1904.	Tractive power.	Average total weight, engine and tender in working trim. tons	cwt.	qrs.	Average cost per locomotive on traffic.	Date placed on traffic.
			lbs.	tons	cwt.	qrs.	£	
A	Shunting	8	6,642	32	2	2¼	2,010	1883–1894
B	Do.	11	10,425	32	0	0	2,322	1884–1899
C	Mixed and Mail	12	16,500	67	10	0	3,267	1902
D	Shunting	..	3,645	12	8	0	1,500	1884
E	Exp., Mail, Mxd., & Gds.	45	16,620	83	4	0	5,188	1902
Ec	Do. do. do.	20	16,000	73	0	0	3,236	1901
F	Goods	15	21,115	81	8	2	5,998	1902–1903
G	Mxd., Shunting, & Gds...	63	10,915	42	12	2	2,403	1889–1899
H	Shunting	2	3,780	14	1	0	955	1889–1890
J	Mxd., Gds., & Shunting..	3	9,620	49	0	0	2,556	1892
K	Goods	24	16,770	53	0	0	2,416	1893–1898
L	Shunting	1	9,800	30	10	0	..	1891
M	Do.	2	6,290	30	0	0	2,340	No record
N	Suburban Passr., Exp., and Mail	32	12,610	44	4	0	2,951	1896–1901
O	Goods & Slow Mixed ..	46	16,810	58	9	0	2,978	1896–1898
P	Passr., Mixed, & Goods..	2	8,435	51	1	0	2,540	1896
Q	Shunting and Goods ..	6	14,135	39	0	0	2,520	1896-1897
R	Express, Mail, & Mixed .	24	11,855	55	16	0	2,705	1897–1899
S	Shunting	2	5,030	17	0	0	1,000	1888–1892
T	Passr., Mixed, & Goods .	10	9,080	49	16	0	2,750	1888–1890
U	Loco. Crane	1	14,292	37	14	0	4,050	1904
		329	..	..			..	..

*

British Railway Rates *v.* Foreign.

To a recent issue of the *Monthly Review* Mr. Edwin A. Pratt contributed a particularly able and concise reply, so far as it concerns railways, to the article in the same Review for October last, entitled "How Englishmen are Destroying England," by Mr. F. S. Tatham, Member of the Natal Parliament.

Mr. Pratt clearly proves that Mr. Tatham has compared "unlikes" with the usual result that befalls those who do so. Moreover, Mr. Tatham does not appear to be quite familiar with the thorny subject of Railway Rates, and his inferences and statements suffer accordingly. But Mr. Pratt, in the telling sentences quoted below, gives many reasons why British railway rates might justifiably be higher than those on State-aided railway systems.

"The confession may frankly be made that there would, "in effect, be no cause for surprise if comparisons between "British and foreign railway rates should be to the disad- "vantage of the former. No element has been lacking to "render British railways among the most expensive to con- "struct and maintain of any in the world. The companies "had to pay the most exorbitant sums for the land on which "their lines were constructed; they have been forced to "organise their systems from almost the first with a perfec- "tion to which the American railways especially are now "only just attaining; they have been subjected to a control "more severe, and more costly, than the railways of any "other country; they have to bear the burden of local taxa- "tion to such an extent that they are now paying four and a "half millions sterling per annum under this head, individual "companies having to contribute 60, 70, or 80 per cent. of "the local rates in many parishes where they have not even "a railway station; they have been compelled, when building "new termini, or widening their lines in order to meet the "public convenience, to provide—ostensibly for the persons "unhoused, in reality for an altogether superior type of "people—dwellings of which the rental has been fixed by "the Home Office at sums that did not even cover expenses; "and they have had to assume the *rôle* of philanthropic "institutions in running workmen's trains at fares leaving "little or no margin for profit."

We do not think we ever saw the case more admirably put in so few words, and we commend them to the careful consideration of our railway "experts" and critics.

*

Automatic Stokers for Locomotives.

Mr. Wm. Forsyth at the International Engineering Congress stated, says the *American Engineer and Railroad Journal*, that the necessity for an automatic stoker for the large locomotive, either passenger or freight, is quite generally recognised, and the requirements have been met in a very satisfactory manner by at least one form of stoker. It is strange, therefore, that a stoker which has been upon the market for several years, and which works so successfully, does not become regularly adopted by the railroads, which seem to need some such appliance to assist the fireman in his arduous work. The testimony as to the success of this device is the most convincing of any relating to locomotive improvements (containing such radical changes in methods of operation) which have been introduced in many years. The reports of the laboratory tests at Purdue show it to have given a very satisfactory performance. The testimony of motive power men who have had quite a number of stokers

in use is entirely favourable to the device, and the opinion of the superintendent of our largest locomotive works is that the stoker is the coming device.

Cost of Carriages in West Australia.

During the year ended 30th June last the West Australian Government imported from the Gloucester Carriage and Wagon Co. nine 2nd class corridor bogie cars, having an average seating capacity for 48 passengers. Their average tare was 28 tons 15 cwt. and their average cost on traffic £2,792. Gauge of railways 3 ft. 6 ins.

"Too many Signals."

The publication of Major Pringle's report* upon the collision which occurred at St. Enoch's Station, Glasgow, on 17th September last, has excited considerable interest in the daily papers, some of which waxed quite eloquent on the subject of "Too many Signals."

The signalling of St. Enoch's Station and neighbourhood was fully described and illustrated in the *Railway Engineer* for September, 1902, and, as was then pointed out, it provides for every possible running and shunting movement; in short, St. Enoch's is the most completely-signalled station in the country. The installation was inspected by Col. Yorke, who, we understand, complimented the Glasgow and South Western R. Co. and the W. R. Sykes Signal and Interlocking Co. (the contractors) on the work, and therefore this report of Major Pringle deserves more than usual attention.

In order to reduce the amount of interlocking, and also to detect the switches and "hold the road," route-levers are provided for each road and each road has also its own signals. For instance, on a signal bridge outside the station there are splitting running signals from No. 1 road for going on to the up loop or on to the up Canal line, also two shunting signals leading to the same roads. No. 1 middle road has two shunting signals, whilst No. 2 road has two running and two shunting signals. These signals it must be observed are in advance of the splitting points and consequently their meaning is not quite clear. The signals are, however, necessary, and whilst it is unfortunate that they are fixed in advance of the points, yet they "hold the road," and were they fixed in the rear of the switches the confusion would be greater. In the evidence two drivers said they had found difficulty in reading the shunt signals, and the signalman at the station box said: "I have heard enginemen talking, both previous and subsequent to the collision, about the difficulty of reading the shunting signals on the bridge out of No. 1, No. 1 middle, and No. 2 roads. They have asked me to explain them, and seemed to understand. This has been on more than one occasion. They did not see why there were so many signals applicable to one road, and said that the signals told them where they had come from, instead of where they were going to. They seemed satisfied after an explanation."

On the occasion of the accident a driver on the loop thought he had been crossed on to the up Canal line, and seeing the home signal for that line at Clyde Junction off he proceeded. He was, however, still on the loop line and his signal was at danger; the Canal signal was off for a passenger train, which he collided with at the junction of the two lines.

In justice to the driver it should be noted that the printed instructions as to the signals at St. Enoch's station only state where the shunting signals are from, and not where they lead to, and Major Pringle remarks that in this respect the instructions are incomplete and require amplification. The inspecting officer, however, draws attention to the fact that the proper signal for the driver was on his left, whereas the signal he mistook was on his right.

The most important parts of the report are the two last paragraphs, the first of which reads: "It is highly desirable, both from the point of view of safety and for traffic purposes, that signalling in a large terminus should be as complete as possible. At the same time there is a danger to be guarded against, namely, confusion, owing to a multiplicity of signals."

Does the Major consider there are too many signals at St. Enoch's? If so he should plainly say so, and the matter could then be discussed. If, however, he is not of that opinion (and one is forced to that conclusion by the evidence and by the silence of the inspecting officer, excepting this one observation), then it is to be regretted that he took this opportunity for volunteering this platitude.

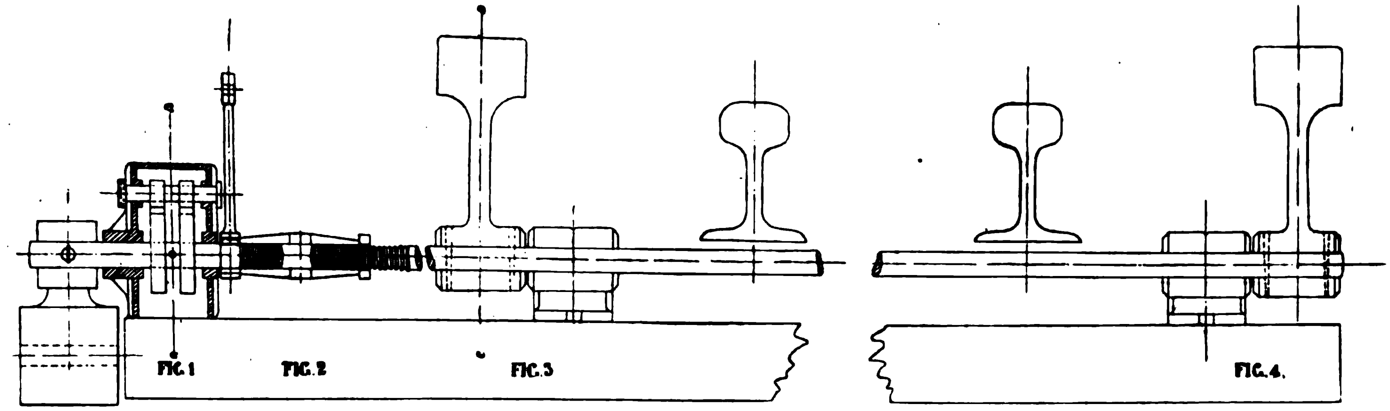
The other important paragraph reads as follows: "The evidence in this case points, I think, to the necessity for adopting some method of ensuring that enginemen, especially those who are only occasionally called upon to work in a large terminus, are thoroughly conversant with the working arrangements and signalling. It does not appear to be sufficient to issue printed signalling instructions." We cannot, however, see what is to be done unless engine drivers apply for a pilot. It is a difficult subject, and that is probably why no suggestion for solving the difficulty is offered.

One point Major Pringle omitted to deal with, and that is, how it was that the light engine approached Clyde Junction when the signalman there says he had not accepted it from the station box, and it is only on turning to the diagram given in the *Railway Engineer* for September, 1902, already referred to, that it is clear how this came about. It appears that the home signals for Clyde Junction are slotted from the station box, and act as starting signals for that cabin, and therefore the man at the latter place was allowed to permit the light engine to draw forward. This is often done at other places, but it seems to us to be a breach of absolute block working, and one that the Board of Trade might reasonably be expected to take notice of. Such slotting is often necessary where only a short distance exists between signal boxes, and one is closed at times, as by controlling the home signal of the box that is closed from the box in the rear, the open section is lengthened and traffic movements facilitated. Quite possibly such slotting is necessary at St. Enoch's to control shunting movements, but such facilities should not be abused, especially when risks as those exposed by the collision under notice are run, and we commend the facts to the Rule Book Committee of Clearing House and the Board of Trade.

* Major Pringle's Report will be found on page 62 of this issue.

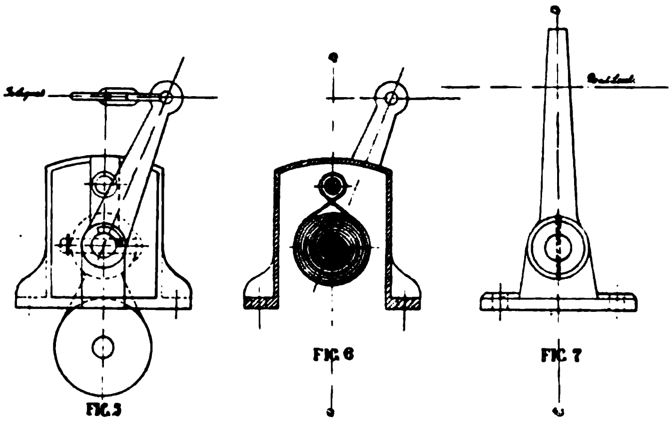
Brierley's Improved Fog-Signalling Apparatus.

Recent railway accidents, more or less directly attributable to fog, have again accentuated the necessity for some additional signalling appliance such as the one devised by Mr.



Wynford Brierley, and with which during the last few years trials have been successfully made on the Great Northern R.

Some time ago* we drew attention to Mr. Brierley's apparatus, which has lately been improved and simplified by dispensing with its electrical portions. Its cost has thereby been reduced, and the views of railway engineers, both at



home and abroad, who had expressed a preference for a purely mechanical device, have been met.

Mr. Brierley claims to have designed an appliance the mechanism of which will continue to sustain the repeated blows due to the contact between the trigger on the engine, moving at express speed, and the stationary part of the apparatus fixed on the track; and which is practically without intermediate frictional gear between the striking trigger and the bell or other signalling appliance; and of which the stationary part will not be broken or displaced should it be struck by anything rigid on a train.

The mechanism is illustrated by the annexed drawings. Figs. 1 to 7 show the road apparatus, which consists of a shaft passing under the rails, and to which are fixed by means of pins arms the normal position of which is vertical. These arms are on the outside of each rail to allow for engines travelling either end first. Another arm is mounted on the shaft, and to this the signal wire is attached, so that the contact arms would be "pulled off" simultaneously with the signal arm. The shaft is maintained in its normal position by two springs coiled in opposite directions, fig. 6, and also by a balance weight. These springs also absorb the energy of the impact when the trigger strikes, and prevent the mechanism being broken. They also allow the arms to give way before anything rigid, and subsequently return them to the normal position. In order that the shaft may turn without straining the signal wire, the key way in the boss of the operating lever is cut away, as shown in fig. 5.

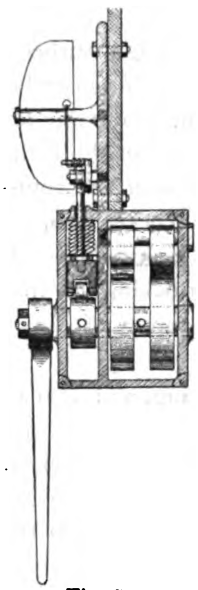


Fig. 8.

The apparatus fixed to the engine, fig. 8, consists of a trigger hung on a shaft and controlled in a central position by similar reversed coiled springs to those above mentioned. On the shaft is also mounted a cam, which, when the trigger has struck the contact arm, oscillates under the lower end of a vertical spindle (provided with a friction roller), the upper end of which operates the hammer of a gong. Of course, if preferred, the gong may be placed on the cab, as on the Great Northern engine, which has been fitted. But it is suggested that the step would form a convenient point of attachment.

We have on more than one occasion pointed out the limits of usefulness of such appliances as the one described.

* See *Railway Engineer*, July, 1899.

The Diamond Stair Tread.

In appearance this tread is very similar, as regards construction, to the lead strip treads. It consists of a rolled strip of steel having dove-tailed grooves above $\frac{5}{16}''$ wide filled with a composition of special cement and carbon crystals. The grooves holding the composition are divided by **V** shaped furrows about $\frac{3}{8}''$ wide.

The carbon crystals, with which the cement is combined, are of the hardest known abrasive substance, except the diamond. It easily cuts glass or hardened steel, and is successfully used for polishing diamonds.

The cement that combines the carbon crystals is practically artificial stone, and headstones and monuments made of this cement have been standing for over 12 years exposed to the atmospheric conditions without showing the least particle of decay in any respect. This, when combined

with the carbon crystals, creates a tread which is so much harder than steel that the steel foundation channels are protected, but eventually wear away faster than the tread, and, therefore, leave the tread constantly exposed to do its work.

In those treads made of lead strips these conditions are reversed; the lead is so much softer than the steel channels that it wears away faster, and leaves the channels exposed to take the wear and become polished and slippery.

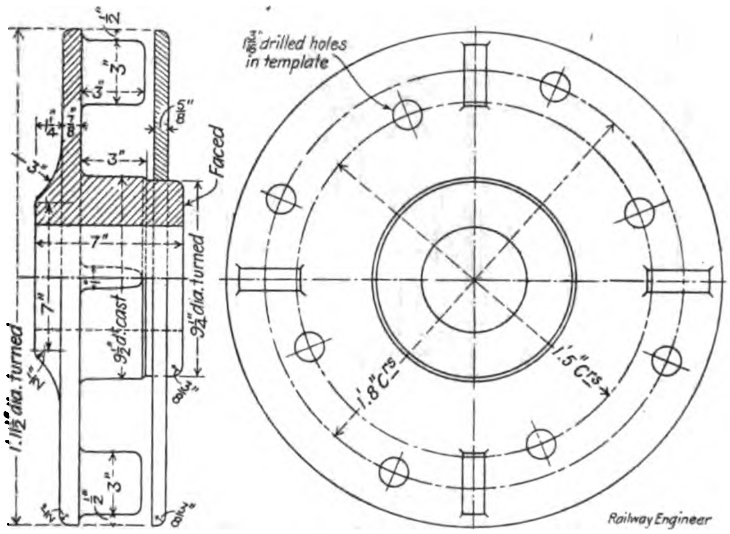
The diamond tread is impervious to water or fire. It is absolutely non-absorbent, and consequently can contain no water to freeze or cause slipping in extremely cold weather.

Any heat arising from fires in buildings will in no way affect it, so that it retains its non-slipping surface under any and all conditions until completely worn out.

This tread is, we consider, a great advance on anything of the kind which has hitherto been introduced and should commend itself to railway engineers and carriage and tram car builders. It is manufactured by the Diamond Tread Co. in London, for whom Messrs. Knowles & Wollaston, 26, Victoria Street, London, S.W., are the sole selling agents and who will be pleased to furnish any other information that may be desired.

Boardite Wheels.

We have on more than one occasion previously referred to the "Boardite" wheels, the features of which are that they are made in a very short time by unskilled labour, mainly out of a waste product, viz., sawdust, and are formed by one operation, without any joints, into the tyre and round the boss without the aid of any other tools except an hydraulic press capable of exerting pressure of about 500 tons.



We have had an opportunity of seeing some of these wheels made for a foreign railway, and we understand that when they were put on to the balancing machine they were found to be dead true and required no balancing plates whatever.

We illustrate herewith the new standard boss which has recently been patented by the Boardite Co., Ltd., and which, it will be noticed, has four projections cast on the flange, so that when the "Boardite" is pressed home over them and bolted up it is impossible for the boss to slip.

We understand that several railway companies are trying these wheels.

The Boardite Co. has recently introduced a platform truck wheel with a convex tyre filled with "Boardite," the object of which is to do away with two objectionable features which flat iron wheels have, viz., the cutting of the platform flags or boards, and the noise they make.

These wheels have already attracted considerable attention from railway companies, and as they have a tread on the platform of only about ⅝ in. and even at 14 in. diameter will bear a weight of 2 tons, there should be a large field for their use. For tramway work "Boardite" wheels with mild steel tyres have, we are informed, proved to be far superior to chilled wheels, and for heavy motor vehicles requiring wheels of great strength and durablilty "Boardite" wheels should be very suitable.

Books, Papers, and Pamphlets.

Received.

Modern Engines and Power Generators; a practical work on prime movers, and the transmission of power, steam, electric, water, and hot air. By Rankin Kennedy, C.E. With 289 illustrations. Vol. IV. London: The Caxton Publishing Company, 84-86, Chancery Lane, W.C. [216 pp.; 10¼ ins. × 7⅜ ins.; cloth, price 9*s*. *net*.]

Railway Brakes. By Stephenson Y. Knight, M.S.W.Inst.E. Published by the Author. 1904. [51 pp.; 9¾ ins. × 6¼ ins., and 3 folding plates; price 4*s*.]

British Standard Specification for Portland Cement. Report issued by the Engineering Standards Committee, Leslie S. Robertson, M.Inst.C.E., Secretary. London: Crosby, Lockwood & Son, 7, Stationers' Hall Court, E.C. December, 1904. [Price 2*s*. 6*d*. *net*.]

Motors and Motoring. By Henry J. Spooner, C.E., Professor of engineering and Principal lecturer in Mechanical Science at the Polytechnic, London. Illustrated. London: T. C. & E. C. Jack, 34, Henrietta Street, W.C., and Edinburgh. 1905. [102 pp.; 6⅞ × 4⅜ ins.; price 1*s*.]

Express Passenger Engine: Midland Great Western Railway of Ireland.

In our issue for November, 1903, we illustrated the express engine "Celtic," which was the first to be built of the class designed by Mr. E. Cusack, locomotive engineer, to whom we are indebted for the annexed drawings. This class of engine is used for hauling the heavy mail and express trains of the Midland Great Western R. between Dublin and Broadstone. The "Celtic" was built at the company's works at Broadstone, Dublin, and is the heaviest engine ever built in Ireland. The engines are economical, and have given every satisfaction in service. The principal dimensions are shown on the drawings and the main particulars are:—

Cylinders 18 ins. diam. × 26 ins. stroke.

Coupled wheels 6 ft. 3 ins. diam.; centre to centre 9 ft. 3 ins.

Bogie wheels 3 ft. 6 ins. diam.; centre to centre 5 ft. 6 ins.

Boiler barrel 4 ft. 10 ins. × 11 ft. long.

Working pressure 175 lbs. for sq. inch.

235 tubes 1¾ ins. diam.

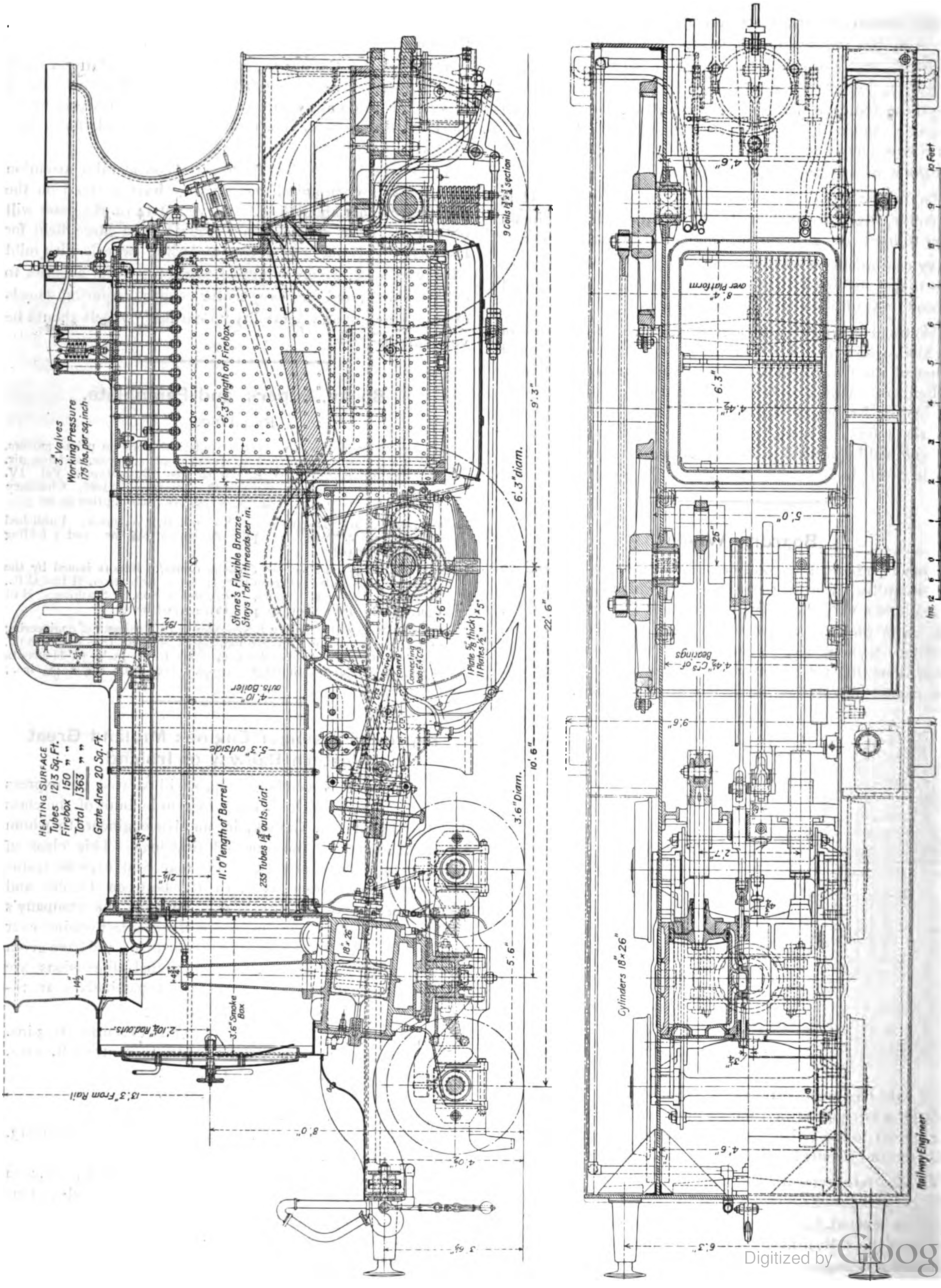
Heating surface 1,363 sq. ft., of which the tubes provide 1,213.

Grate area 20 sq. ft.

Distribution of weight is: on the bogie 16 tons 15 cwt.; on the driving axle, 18 tons 1 cwt.; on the trailing wheels 16 tons 2 cwt., total 50 tons 18 cwt.

Weight of tender 35 tons 16 cwt.

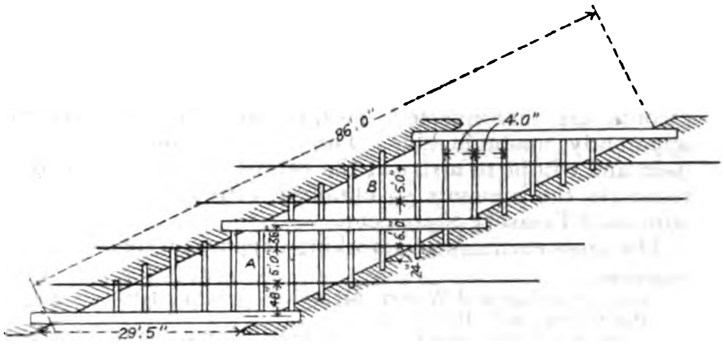
The gauge of the railway is 5 ft. 3 ins.



Express Passenger Engine, Midland Great Western Railway of Ireland.

Economy in Skew Bridges.

When a railway bridge has to be built over a road or waterway which crosses the line of railway at a sharp angle, a great saving of material may often be effected by adopting a type of construction suited to the circumstances.



As an instance of this, the plan is given of a bridge in the North of England, the span of which is 29′ 5″ on the skew and 12′ on the square.

The bridge carries two lines of rails, and consists of two face girders, a centre girder, and cross girders.

The centre girder might well have been dispensed with, the cross girders now bearing on it being carried right through from one abutment to the other. The calculations given below show that there would have been no need to increase the section of the cross girders if this arrangement had been carried out, and as no more load would have come on the face girders, the weight of material in the centre girder might have been saved.

The track being laid on large longitudinal timbers, the moving load may be taken as uniformly distributed, and for a heavy engine, equivalent to two tons per foot run on each road.

The calculation of the stress produced in the cross girder marked A, by this load, follows :—

Span (between main girder webs) = 12 ft.
Depth between centres of gravity of flanges = 0·85 ft.
Net area of bottom flange (two) $3\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{1}{2}''$ angles — two $\frac{7}{8}''$ holes = 5·6 sq. ins.
Dead load on cross girder = ·9 tons.
Moving load on each rail 4 ft. × 2 tons ÷ 2 = 4 tons.
Maximum stress per sq. in. in bottom flange :—

$$\frac{\cdot 9\text{ T} \times 4\text{ ft.} \times 8\text{ ft.}}{2 \times 12\text{ ft.} \times \cdot 85\text{ ft.} \times 5\cdot 6\text{ sq. in.}} + \frac{4\text{ T} \times 4\text{ ft.} \times 8\text{ ft.}}{12\text{ ft.} \times \cdot 85\text{ ft.} \times 5\cdot 6\text{ sq. in.}} + \frac{4\text{ ft.}}{9\text{ ft.}} \times \frac{4\text{ T} \times 9\text{ ft.} \times 3\text{ ft.}}{12\text{ ft.} \times \cdot 85\text{ ft.} \times 5\cdot 6\text{ sq. in.}} = 3\cdot 3\text{ tons.}$$

If the centre girder were removed and the cross girders carried through, the girder marked B would sustain the greatest stress, the latter being calculated as follows :—

Span between abutments = 13 ft.
Depth between centres of gravity of flanges = 0·85 ft.
Net area of bottom flange (two) $3\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{1}{2}''$ angles — two $\frac{7}{8}''$ holes = 5·6 sq. ins.
Dead load on one cross girder 1 ton.
Moving load on each rail 4 ft. × 2 tons ÷ 2 = 4 tons.
Maximum stress per sq. in. bottom flange :—

$$\frac{1\text{ T} \times 5\text{ ft.} \times 8\text{ ft.}}{2 \times 13\text{ ft.} \times \cdot 85\text{ ft.} \times 5\cdot 6\text{ sq. in.}} + \frac{4\text{ T} \times 5\text{ ft.} \times 8\text{ ft.}}{13\text{ ft.} \times \cdot 85\text{ ft.} \times 5\cdot 6\text{ sq. in.}} + \frac{5\text{ ft.}}{11\text{ ft.}} \times \frac{4\text{ T} \times 11\text{ ft.} \times 2\text{ ft.}}{13\text{ ft.} \times \cdot 85\text{ ft.} \times 5\cdot 6\text{ sq. in.}} = 3\cdot 6\text{ tons.}$$

Even this small excess of stress would scarcely ever be produced, as it requires the maximum load to be on both roads at the same time.

From the weights of the girderwork it is interesting to determine what percentage of material might have been saved.

Weight of two face girders = 4 tons.
„ „ centre girder = 3·5 „
„ „ cross girders = 5·4 „ Total 12·9 tons.
Percentage of total in centre girder

$$3\cdot 5\text{ T} \div 12\cdot 9\text{ T} \times 100 = 27\%$$

It is a question when a bridge is so much on the skew whether it is not more economical to build the girders across the opening instead of along the rails. There are many bridges built on this principle, but they appear to be mostly over rivers and canals. Such a bridge, which is really a short tunnel, would make a roadway inconveniently dark, or it may be that whereas a road can be adjusted to prevent a very sharp crossing with a railway, the deviation of a waterway is a more expensive process. Hence bridges of large skew are more common over rivers and canals than over roads and footpaths.

In the case already referred to an estimate of the quantity of ironwork, which would be required to build a bridge with girders normal to the abutments, can easily be arrived at. The span on the square is 12 ft., the same as the span of the existing cross girders. Hence, girders of the same section as the cross girders, namely $12'' \times \frac{3}{8}''$ webs and flanges each formed of (two) $3\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{1}{2}''$ angles, and spaced 4 ft. centre to centre in the direction of the rails, would be strained to approximately the same extent as the girders in the existing bridge, and a fair comparison thus made.

The length of these girders may be taken as 16 ft. and the width of a square bridge 86 ft.; 4 ft. measured in the direction of the rails is equivalent to 3′ 6″ measured along the abutments, hence the number of girders required will be 86 ÷ 3·5 + 1 = 25.

Taking the weight of the girders as described above at 60 lbs. per ft., the total weight of girderwork for a square bridge would be 25 × 16 ft. × 60 lbs. ÷ 2,250 = 10·7 tons.

Thus, comparing the three types of construction—

Weight of skew bridge with middle girder = 12·9 tons.
„ „ „ „ without „ „ = 9·4 „
„ „ square bridge = 10·7 „

On considerations of economy these figures would give the first place to a skew bridge without a middle girder. It would be hardly fair to give the second place to a square bridge, as against the saving of ironwork must be placed the cost of the necessary extension of the abutments.

West Australian Government Railways: 1903-4.

The Annual report of the Railway Commissioner, Mr. Wm. J. George, upon the working of the West Australian Government Railways during the year ended 30th June last, states that the length of the main lines open for traffic was 1,541 m. 27 chs. and of the sidings 213 m. 5 chs. During the year 23 m. 43 chs. were opened for traffic at an additional capital cost of £46,921.

The Upper Darling Range Branch was purchased by the Government under Clause 37 of the Agreement regarding the construction of the line, made in 1891 between the Government and the late Mr. E. V. H. Keane, the price payable being £1,000 per mile. The general condition of the line when taken over was extremely bad: banks and cuttings narrow, accommodation and water supply insufficient, and appliances for safe working almost entirely lacking. To remedy these defects it was estimated that an expenditure of £14,000 would be required. During the year over £8,000

was expended in work necessary to bring the line towards a proper standard of efficiency, and still further sums are being and will have to be spent in this direction. The effect of opening this line has been to divert from the Eastern Railway and the Smith's Mill branch traffic which could have been worked more profitably on those lines. The main traffic (timber), has practically ceased owing to the area being cut out, and the consequent closing of the Canning Jarrah saw mills.

It has been inadvisable to use the Collie-Collie Boulder Extension for through passenger traffic, owing to extensive undermining near Collie. Except for coal traffic, and a few local passengers, it is practically of little value to the Department for revenue purposes. An expenditure by the Department of, approximately, £1,000 is being undertaken to fill up the workings under the line in such a manner as to render the surface free from danger of subsidence. The coal traffic is unprofitable, as the Department is practically the sole customer of these mines, and all the coal required by the Department could have been obtained from mines at Collie, and so saved the capital expenditure and the cost of working.

The Malcolm-Laverton extension (about 64 m. long) under construction by the Public Works Department will be handed over to the Railway Department early in 1905.

Financial results of the working were :—

	£
Working expenses	1,179,624
Interest on loan capital	277,181
Interest on capital from other sources ...	19,495
Total	1,476,300
Net credit balance	111,784
Receipts	1,588,084
Total receipts	£8,955.929

Results of Working for Year compared with those of previous Year.

		Difference.
Total amount debited on Cap. Acc.	£8,955,929	+ £814,147
Average number of miles worked	1,535	+ 101
Cost per average mile worked ...	£5,834	+ £156
Total amount debited for interest	£296,676	+ £21,951
Gross earnings	£1,588,084	+ £34,599
Working expenses	£1,179,624	− £68,249
Surplus over working expenses ...	£408,460	+ £102,848
Surplus over working exps. and int.	£111.784	+ £80,897
Working expenses to earnings ..	74·28 %	− 6·05 %
Surplus to capital	4·56 %	+ ·81 %
Earnings per average mile worked	£1,034	− £49
Working expenses per average mile	£768	− £102
Net return per average mile worked	£266	+ £53
Train miles run	4,594,234	− 17,081
Earning per train mile	82·96*d*.	+ 2·11*d*.
Working expenses per train mile ..	61·62*d*.	− 3·33*d*.
Net return per train mile	21·34*d*.	+ 5·44*d*.
Passenger journeys	10,225,976	+ 1,119,580
Paying goods tonnage	2,032,740	+ 259,103
Depart. goods tonnage (non-paying)	224,494	+ 51,182
Live stock tonnage ...	24,530	+ 3,148
Total tonnage, goods and live stock	2,281,764	+ 313,433
Coaching revenue	£462,455	+ £25,223
Goods revenue (including live stock)	£1,026,734	+ £42,857
Miscellaneous revenue	£98,895	− £33,481
Miles open for traffic (main line)...	1,541	+ 25
Locomotives	329	+ 13
Passenger vehicles...	269	+ 5
Brake vans	127	+ 14
Goods vehicles	5,632	+ 51
Equivalent of goods vehicles in four-wheel wagons	7,551	+ 63
Total number of persons employed on 30th June	6,747	+ 506
Average number of persons employed during whole year, exclusive of casual hands	5,616	......

The result of working was most gratifying and resulted in the largest return of profit on record since the Government has owned railways.

The increased average mileage worked throughout the year was 101 miles.

The earnings increased £34,599, and expenses decreased £68,249, a total of £102,848 difference.

The Capital figures have been calculated as nearly as possible with the information available. The matter is, however, not in a satisfactory position. A thorough investigation into the whole account is in progress. Information and records are disconnected, meagre, and in some instances apparently unobtainable. The object of investigation has been and will be to arrive at the details of expenditure and to reconcile the amounts so obtained with those contained in published Treasury Statement.

The gross earnings and working expenses were :—

Expenditure—	£	£	%	%
Loco., Carriage and Wagon	547,868	− 40,454	34·50	− 3·37
Rebuilding and Replacing obsolete Rolling Stock ..	33,787	− 20,699	2·12	− 1·39
Permanent Way	236,089	+ 4,119	14·87	− 0·06
Traffic and Jetty	306,998	− 5,366	19·33	− 0·78
Compensation	3,940	− 868	0·25	− 0·06
Electrical (including Telephones and Light) ..	22,487	− 4,544	1·42	− 0·32
Signalling and interlocking	5,854	− 693	0·37	− 0·05
Generally	22,601	+ 256	1·42	− 0·02
Total	1,179,624	− 68,249	74·28	− 6·05

Receipts—	£	£
Passengers	398,067	+ 17,345
Parcel, Horses, Carriages, &c.	64,388	+ 7,878
Cloak Room	2,691	− 83
Mails	19,340	+ 9,669
Goods and Minerals	996,175	+ 42,744
Live stock	30,559	+ 113
Wharfage and Jetty Dues ...	40,215	− 22,448
Rents	18,861	+ 3,694
Miscellaneous	17,788	− 24,313
Total	1,588,084	+ 34,599
Train Miles	4,594,234	− 17,081

The decrease in working expenses is the result of careful economy in all branches, and also of the use on the heavy road, completed in 1902-1903, of the heavy type of locomotive introduced by the late chief mechanical engineer, Mr. T. F. Rotheram. Notwithstanding the increased average mileage in operation, and the increased volume of business in every direction, train mileage has been decreased 17,081 miles. To this fact the general decrease in all branches may be attributed. The decrease (£20,699) in re-building rolling stock due to the completion, prior to 1st July, 1903, of an expenditure of £56,280 undertaken to spread over the years ending 30th June, 1902 and 1903, in equal proportions. This was incurred for the purpose of bringing up to standard 1,399 old and crippled wagons, which required re-building or repairing beyond ordinary maintenance.

Revenue shows satisfactory increases under practically all headings. The decrease from wharfage (£22,448) is due to the fact of the Harbour Trust having controlled the wharves at Fremantle during the whole year, whereas in the previous year they controlled them only during the second half of the year. The decrease in miscellaneous items is due to an improved method of classifying revenue which has been adopted. It is worthy of note, for comparison with former years, that expenditure has had to bear the following :— Extra pay to station-masters, officers in charge, and night officers. Extra pay under Industrial Agreement relating to Traffic Wages Staff, and others of the Way and Works, Electrical, and Interlocking Branches. Overtime payments to Loco. Running Staff under Industrial Agreement. The operation of the Eight Hour Day to practically all grades. Heavier maintenance charges on permanent way.

The most noticeable increases for 1903–1904 in the goods

traffic are in ores, slimes, and tailings, 183,740 tons, as compared with 73,411 tons in 1902–1903; grain totalling 93,396 tons, as compared with 57,849 tons; potatoes 18,143 tons, as compared with 10,319 tons; and locally grown timber, plus 8,815 tons "On Service," totalling 419,698 tons, as compared with 328,130 tons. On the other hand there are considerable decreases in dairy produce, 8,972 tons, as compared with 15,580 tons, and "all other goods not classified above," 195,963 tons, as compared with 248,130 tons. All material required in connection with new works of addition and improvement to the working railway system is now carried entirely free of freight.

All particulars in which the cost of working the several sections of the systems has been separately concerned are omitted in this Report. The reason for this important change is that the only means by which such expenditure has been arrived at was on the basis of the expenditure per train mile; that is to say, if the total expenditure of the Department for the year, divided by the total train mileage run, showed a cost of (say) 5*s.* per train mile, and of that total train mileage 1,000,000 train miles had been run on (say) Eastern Goldfields Railway, then the cost of working the Eastern Goldfields Railway was said to be £250,000. It appeared that to publish statements of sectional expenditure based on such a rough and ready method was entirely misleading for any purpose of accurately considering results. In the case taken for example—the Eastern Goldfields Railway—no account was taken of the payment of the goldfields allowances to every employee east of Yerbillon, averaging £20 per man per annum, nor was any debit made for the extra cost of fuel and other stores by haulage to Kalgoorlie or other distant depôts, nor for the cost of water, which is extremely heavy on this section as compared with districts nearer the coast. These charges, which are quite peculiar to this particular section, were merged into the whole expenditure, and, therefore, in the tables showing sectional expenditure, not only was the expenditure of this particular section shown as being lower than it should be, but the cost of other sections was really increased by reason of the average expenditure per train mile throughout all lines (including the peculiar items of expenditure above referred to) being taken as the basis of calculation of expenditure. Locomotive coal mileage, which is treated as unproductive mileage and not included in train mileage, presents another phase of the question. The South Western Railway, for instance, carries not only its own coal, but also coal for the Eastern and Eastern Goldfields Railways as well, and the Eastern Railway carries coal for the Eastern Goldfields Railway as well as its own. But the debit made by taking the train mileage basis is exactly the same for coal used at Collie station as it is for coal used at Leonora. Water trains are similarly treated as unproductive mileage, and are not included when the average expenditure per train mile is arrived at; consequently no debit is made for the haulage of water, of which, in effect, by far the largest portion is incurred between Kalgoorlie and Leonora.

The question of accurately arriving at sectional expenditure, in fact, bristles with difficulties, but one thing appears to stand out prominently, and that is that, so far as the railways of this State are concerned, the train mileage basis is unreliable and misleading for such a calculation.

A considerable expenditure will be necessary for building a new station and yard at Fremantle, but it will be impossible to commence active operations in connection therewith until after the complete removal of the old loco. workshops. If, however, it is the intention to proceed with the work, provision should be made for the expenditure of about £40,000 during the current year, and a further £40,000 during 1905-1906.

Provision for a permanent supply of water for use at Midland Junction, and improvements to the passenger and goods accommodation at that station, are required; provision also for fencing through settled districts—of which a considerable amount was done last year—and further duplication of lines requires to be made at the earliest possible moment.

A contract has been made for the first extensive construction of rolling stock in the State, an order for 18 passenger carriages, to be built at North Fremantle at a cost of £57,000, having been placed with the Westralia Ironworks, Ltd. The first coach is to be delivered in January, 1905.

It is proposed also to build at the Midland Junction Workshops 500 four-wheel wagons, using local timber of proved value for the frames, and strengthening and using material on hand. The cost is expected to amount approximately to £36,000.

Having decided that the accountancy work for the whole department should be placed under one head, *i.e.*, under the chief accountant, the accounts of the way and works, and chief mechanical engineer's branches, which mainly included the checking and the preparation of the paysheets, wages abstracts, shop and expenditure accounts, and maintenance of staff records were taken over by that officer during the year.

The general result has been satisfactory, and as time goes on and the officers become better accustomed to the practice, better results will follow, but until suitable office accommodation is provided the effect of the work must be more or less discounted.

The further concentration of similar work now performed by the traffic and stores branches will be taken in hand as soon as conditions are favourable.

The benefit derived from the work done, and which enables the vacuum brake to be applied throughout on a large percentage of trains, is already very marked. The work proposed will largely increase the brake power by enabling the vacuum brake to be applied to 750 trucks, which are now equipped with hand brakes only. It will also complete the fitting of all vehicles with the train pipes, and thus enable the vacuum brake to be used on all trains without heavy expense in marshalling, &c.

Barracks for accommodation of trainmen have been built at Merredin, Karalee, and Brunswick Junction. These barracks have been constructed of portable cabins placed on a flooring of old sleepers, and the whole establishment covered with a second roof. The circulation of air, combined with the shade, afford the maximum degree of coolness possible which is so necessary for those whose duties necessitate their sleeping during the day. At the same time the whole establishment can be readily and economically removed in the event of alteration in the time-table rendering removal desirable.

The question of price debited the Railway Department in respect of water at Kalgoorlie has been the subject of negotiation throughout the year, though so far without result. The Railway Department claim that the price charged by the Goldfields Water Supply Administration—6*s.* 3*d.* per 1,000 gallons—is excessive, and that it should at least be placed on the same footing as the mines, which pay 5*s.* per 1,000 gallons only. As a customer for nearly 70,000,000 gallons, the Railway Department should, in my opinion, be placed on as favourable terms as are conceded to other large customers. The difference represents upwards of £4,000 per annum.

Another question regarding water supplies has reached an acute stage during the year, namely, the supply of water conserved in railway dams to the public for domestic and commercial purposes, irrespective of railway requirements. The expense and loss which has been caused by interference with railway supplies—particularly at Broad Arrow, Goongarrie, and Bardoc—has been very considerable, and in some instances water which the railway Department could and would have used with advantage has been locked up for sale to the public, and while waiting to be sold has evaporated. Any semblance of dual control in this matter is disastrous, and the Railway Department should solely control its supply of water, and be absolutely independent as to the source from which this essential factor should be drawn.

The Coolgardie Water Supply water is very valuable to the Department. At the same time it is essential that a good supply of dam water should be available, and it certainly should be rendered unnecessary to haul water from Kalgoorlie

to Leonora for railway purposes, when by the provision of dams this could be avoided.

With the object of assisting the estimable movement for bringing the children of the goldfields to the coast during the summer months, the following fares were arranged :—

		Miles travelled.
From Kalgoorlie to Albany and back	20s. per child ...	1,198
From Kalgoorlie to Fremantle and back	15s. " " ...	672
From Kalgoorlie to Bunbury and Busselton and back ...	20s. " " ...	988
From Cue and Nannine to Geraldton and back ...	10s. " " ...	620

The arrangement permitted of one adult to each 10 children being allowed to travel at double the fare for a child.

From the Eastern Goldfields nearly 500 children were sent. This movement, it is expected, will increase very largely year by year, and the benefits all round can scarcely be estimated.

Cheap Excursions from Perth to Albany, 30s. first and 20s. second class, available for 14 days, were instituted. This year it is proposed to continue these cheap fares and to make a special cheap fare from Kalgoorlie to Albany, of 50s. first class and 40s. second class, and to arrange for the train to run through as quickly as possible, instead of, as heretofore, changing trains at Spencer's Brook.

The policy of the Department will be in every possible way consistent with economy to make these excursions popular, convenient, and within the reach of all. By these means it is expected that a better knowledge of the resources of the State will be more widely diffused among the people, and prove of lasting benefit to the State.

Many reductions and concessions in freight charges, &c., have been brought into operation during the year. In foodstuffs and articles of domestic use there is not a reduction which can be made in railway charges which will reduce the consumer's retail cost by ½*d.* per pound.

If our rates (which are practically the same as in the Eastern States) are to be lowered owing to the persistency of merchants and others, then the paying or non-paying of the Government Railways becomes a reponsibility of the State, and the efforts of the officers can only be directed to economical administration, which, on the other hand, will be counteracted by increasing wages and restriction of action in regard to essentials as to supplies for railway working.

The price paid for Collie coal during the year was 10*s.* 6*d.* per ton, loaded into trucks at pits. The latest contract for Newcastle coal is 15*s.* 4*d.* per ton at Fremantle, Albany, Bunbury, and Geraldton. Some criticism has been directed against the Department in consequence of the silence of last year's report on the subject of Collie coal. Recognising the importance of the establishment of the coal industry in Western Australia, and the particulars in reference to the Collie coal tests not being conclusive, it was arranged that the late Mr. Rotheram should make exhaustive tests during the year 1903-1904, and on his death similar instructions were given to Mr. Hume. These tests have been completed and a report on same placed before the Government. So serious did the result appear that the Ministry have arranged for Dr. Jack, of Queensland, to visit this State in order to make a full and comprehensive inquiry into the matter. Every facility will be afforded by the Department to that gentleman, and his report will be looked forward to with considerable interest.

Under the Industrial Agreements it became necessary for the Commissioner to sit as an Appeal Board, but, after some eight months, owing to pressure of work, this work was transferred to a board consisting of a resident magistrate, one representative for the Department, and one for the employees, and this was embodied in the new Railway Act.

20 appeals were heard by the Commissioner, of which 11 (55%) were dismissed; 4 (20%) modified, and 5 (25%) allowed: 19 appeals were heard by the Appeal Board, of which 12 (63%) were dismissed; 5 (26%) modified, and 2 (11%) allowed.

This Department, at the request of the Minister for Works and Railways, undertook the building of the William Street Bridge, Perth. Tenders were called under the plans prepared by a Mr. Howard, and the lowest tender was £39,500. Being considered unsuitable by the Working Railway Engineers, the plans were re-drawn in the Chief Engineer of Existing Lines' Office, and tenders were again called, with the result that the Departmental plan brought forward a tender from the well-known contractor, Mr. Vincent, for £34,893. The plans provided for the use of a large amount of Donnybrook stone. On examination of the tenders it was found that the value of this was set down as £4,500, and it was decided that this expenditure could be very well done without, especially as the station buildings, with which the bridge had to harmonise, are in brick and cement. The cutting out of this stone brought the tender down very considerably, and when the final certificate is made up it will be found that many thousands will have been saved to the State by the action taken.

In order that the immense amount of correspondence, &c., passing through the Department may be clearly understood, the following list will show the files dealt with each year :— Commissioner 110,000, chief traffic manager 1,500,000, chief mechanical engineer 125,000, chief engineer existing lines 266,000, chief accountant 39,000, chief railway storekeeper 41,000, chief railway auditor 31,000, total 2,112,000.

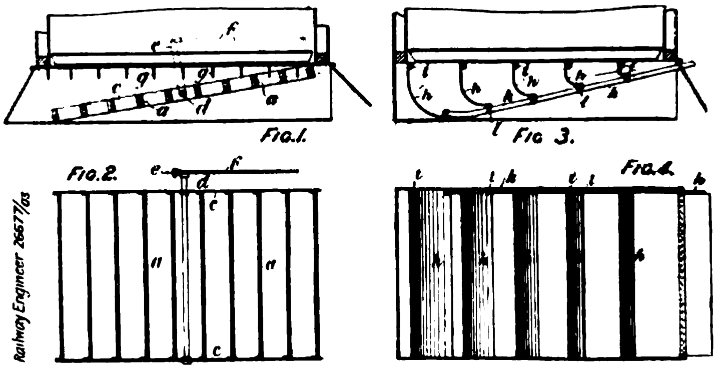
By the scheme put forward the circulation of files can be very largely reduced, and a saving in expense to the Department effected of from £3,000 to £5,000 per annum, if a suitable building plan be adopted and the one record system brought into use as far as possible.

Recent Patents relating to Railways.

These abridgments of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d.* each.

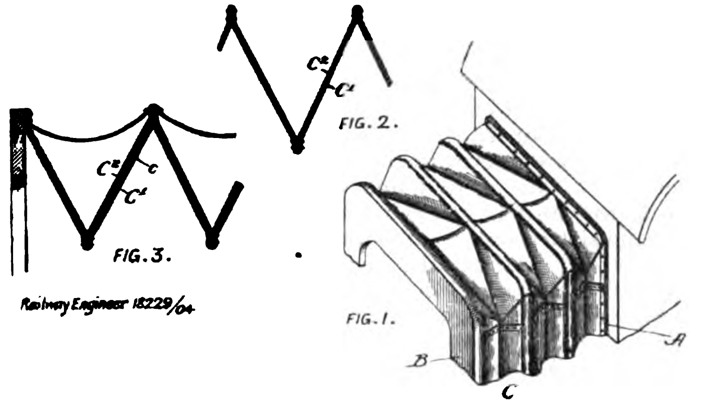
Locomotive Fire-Boxes. 26677. 5th December, 1903. W. R. Preston, of the firm of J. Stone & Co., Deptford, London, and W. S. Rogers, Boxmoor, Cambridge Park, Wanstead, Essex.

This invention consists in the employment of a series of movable or adjustable vanes *a* in the ash pan for deflecting the air and conducting an even supply or even pressure of air from the ash pan to all parts of the grate surface. The vanes



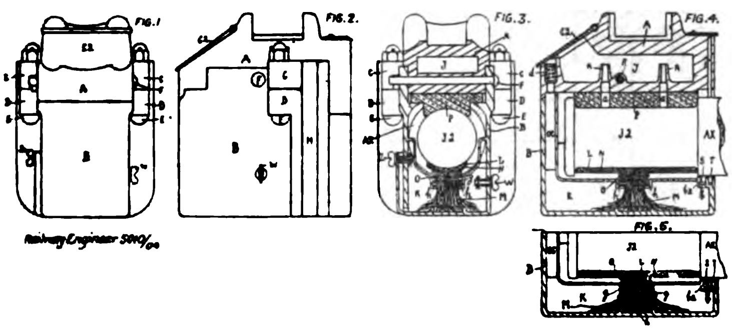
are adjustable so that they can be arranged in the most advantageous manner, irrespective of the direction in which the engine is running, and may co-operate with fixed vanes *g*. In a modified form of construction, adapted for locomotives which run principally in one direction, adjustable curved vanes *h* are pivotally suspended from the sides of the ash pan. (*Accepted 1st December*, 1904.)

Collapsible Gangway. 18229. 23rd August, 1904. G. S. Wood, 77, Jackson Boulevard, Chicago, U.S.A.
This invention relates to a vestibule for connecting cars, provided with a protecting device or hood, designed to keep sparks or cinders from lodging in the folds of the vestibule. The construction comprises a double layer of fabric C^1 C^2 which is folded together in accordion plaits, and then sewed, riveted, or stapled through the plait, rigidly binding the parts in position. Preferably the width of the folds or plaits at the top of the vestibule is wider than in the legs, and two seams or lines of rivets are used, the innermost of which is an inch or more from the bend. The lines of stitching or rivets serve to add to the stiffness of the vestibule top and prevent the



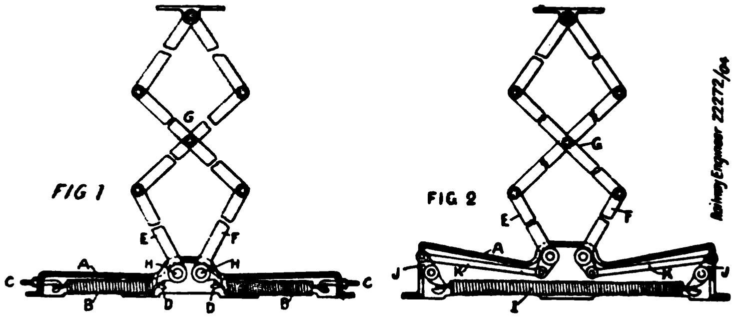
vestibule getting out of shape. Between the folds C^1 and C^2 at the top of the vestibule is inserted the strips *c* of material of sufficient rigidity to support the top of the vestibule. The hood secured to the top of the vestibule consists of a sheet of fabric which is preferably non-combustible and impervious to the weather, having greater width at the ends than at the middle, and secured over and to the top of the vestibule at points along the corners of the vestibule. The hood is of a length sufficient to project at the sides of the vestibule, and the shape is such as to provide a slight fulness at the ends, thereby permitting the fabric to sag between the outer corners of the vestibule sufficiently to shed rain or snow. *(Accepted 3rd November*, 1904.*)*

Axle-Boxes. 5010. 29th February, 1904. D. J. Morgan, 5, Romilly Road, Cardiff, Glamorgan.
The axle-box is made of two parts bolted together and capable of being readily removed from the vehicle after the bolts have been taken out and the weight lifted off the springs by lowering the bottom part away from the vehicle and lifting out the top part between the guides. In the top part A there is a reservoir or chamber J with syphon wick tubes R for oil, when it is used, but when grease is used the



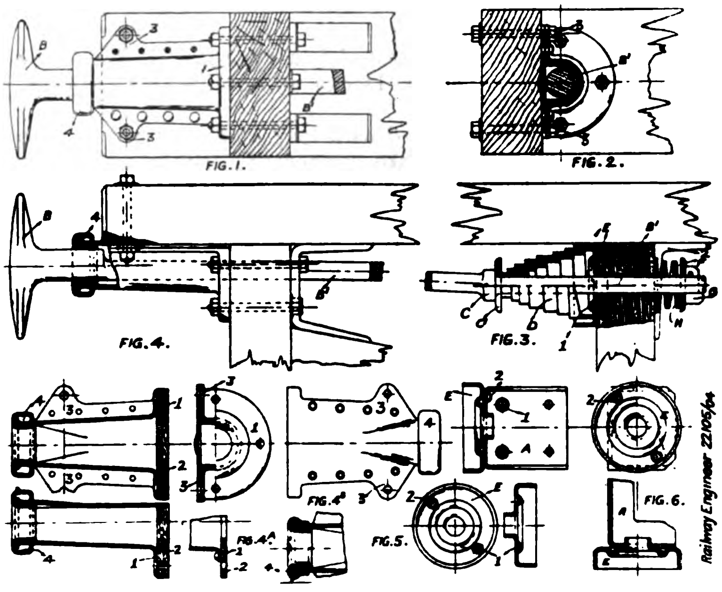
tubes R are removed and the openings filled with plugs adapted to melt at a high temperature and admit the grease to the bearings. An oil reservoir or chamber K in the part B is filled through a passage O C, which connects the chamber K with a channel in the upper part provided with a filter *d*. A plug W is loosened to indicate when there is sufficient oil in the reservoir K, and is also adapted to admit a sounding rod to ascertain the depth of oil at any time. The lubricating pad L is kept in position by a spring O resting either on the bottom of the reservoir or in a recess in the upper part. In a modified construction the lower reservoir may form part of or be fitted to a cover, which can be bolted on to any shape of axle-box. *(Accepted 17th November*, 1904.*)*

Window Lifts. 22272. 17th October, 1904. W. S. Laycock, Victoria Works, Millhouses, Sheffield.
This invention relates to spring mechanism for raising the drop sashes in carriage doors, in combination with a lazy tongs device. The two bottom levers E, F, of the lazy



tongs G, which are connected with the underside of the window frame, are pivoted at H and connected with springs B or I, which are thereby expanded when the window is pushed down, and subsequently assist in raising the window. *(Accepted 17th November*, 1904.*)*

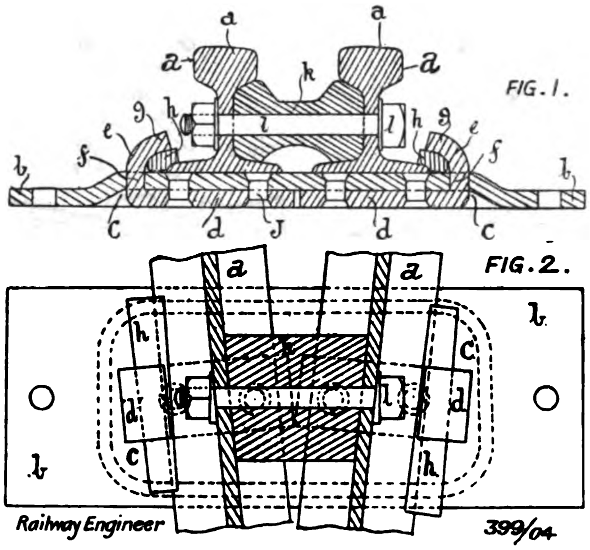
Buffers. 22105. 14th October, 1904. W. Gatwood, 9, Cavendish Road, Chorlton-cum-Hardy, Manchester, and G. H. Willans, The Hermitage, Rhosddu, Wrexham, Denbighshire.
This invention has reference to the construction of spring buffers adapted to be applied to "dead" buffer vehicles and involving a minimum of alteration to the latter. The wooden buffer packing is replaced by a specially constructed buffer guide made of two plates of steel stamped in the form shown



and riveted together. Or the guide may be formed of a single casting with lugs or flanges for bolting to the sole bar and headstock of the wagon. As shown, the buffer plunger B^1 passes through the headstock and through the cross bearer, the buffing spring D being interposed between a washer on the plunger and a cup-shaped socket E on the cross bearer. In order to absorb the shock due to the recoil of the spring D, a light steel or rubber spring is mounted on the other side of the cross bearer. When it is desired to alter the construction of the frame of the wagon and fit a through headstock, the special buffer guide is replaced by the ordinary circular buffer guide. A buffer spring is also described, comprising two springs of different strength, the weaker spring being inserted within the stronger spring, but extending beyond it so that the lighter blows are absorbed by the weaker spring, whilst the heaviest blows are absorbed by both springs. When both

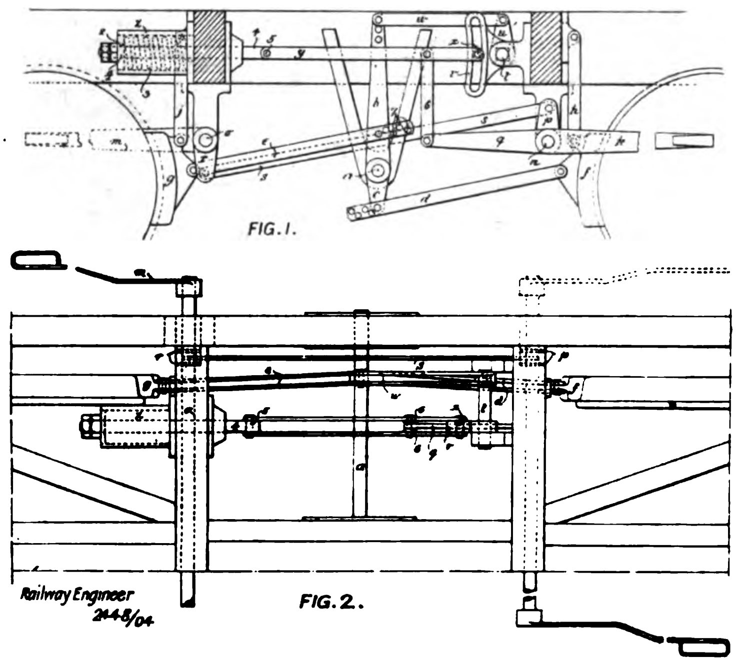
springs are compressed to some extent, inclined faces formed thereon come in frictional contact, and assist in absorbing the buffing strains. *(Accepted 24th November, 1904.)*

Rail Chair. 399. 7th January, 1904. F. W. Bidder, 13, Victoria St., Westminster, London, and Railway and General Engineering Co. Ltd., Midland Engineering Works, Nottingham.
A chair for holding rails at crossings is formed of wrought iron, steel, or cast iron, and comprises a base plate b, bent or deflected upwards at its centre and slotted, and a jaw plate



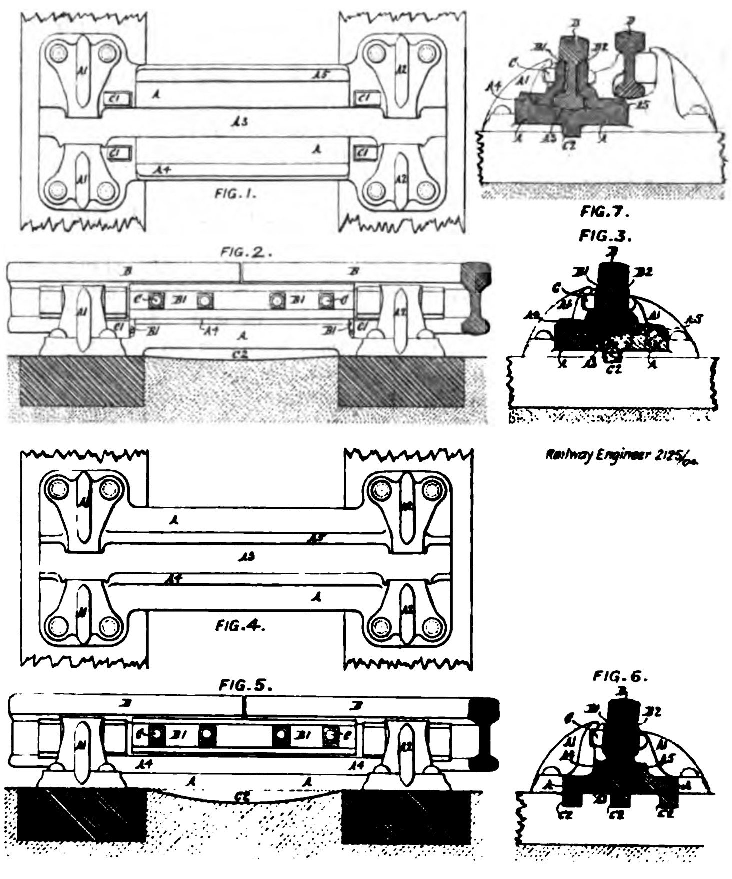
e, with jaws passing through the slots in the base plate. The jaw plate is secured to the base plate by rivets. Taper keys are driven in between the jaws and rails, the latter being also connected by a bolt and distance block. *(Accepted 1st December, 1904.)*

Brakes, Wagon. 2448. 1st February, 1904. J. Macaulay and J. Pattinson, Alexandra Docks and Railway Company, Newport, Monmouthshire.
The brake shaft a is provided with long and short arms b c, to which the brake rods e d are connected. Brake levers are mounted on rocking shafts n o, the shaft n also carrying two



arms p q at right angles to one another, whilst the shaft o carries a short arm r only, which is connected by a rod s with the arm p. On the frame of the wagon is mounted a countershaft t which carries a short lever u and a slotted link v, the short lever u being connected by a link w to the end of the long arm b of the rocking lever, and in the slotted link v is disposed a sliding block or roller x to which is pinned a connecting rod y. On the frame of the wagon and suitably disposed is a cylinder or casing z containing a piston 2 suitably pressed by a spring 3 and provided with a piston rod 4 which is pivotally attached to the connecting rod y as at 5. A connecting link 6 is disposed between the connecting rod y and the long lever q on the rocking shaft n. The spring 3 is preferably spiral and is adjustable so as to be in compression when the brakes are in their "on" and "off" positions. In use when the brakes are in the "off" position the brake levers k and m are "up" and the sliding block or roller x in the slotted link v occupies its lowest position; the lower end of the link v is drawn towards the spring 3 and held there and the long arm b of the rocking lever is held in one of its extreme positions. In applying the brakes the brake lever k is depressed, the long arm q on the rocking shaft n is raised, the sliding block or roller x in the slotted link v is travelled to the middle, drawing the connecting rod y and piston 2 against the spring 3 and then on further movement of the brake lever the sliding block x is travelled to the upper end of the slotted link v when that end is drawn towards the spring 3 thereby causing the countershaft t on which the slotted link v is mounted to rock, and throwing the long arm b of the rocking lever into its extreme position through the lever u and connecting link w and applying the brakes f and g through the brake rods d and e. When the brake is applied by lever m the lever q is raised by the rod s joining the two short arms p r. *(Accepted 1st December, 1904.)*

Rail Chairs. 2125. 28th January, 1904. James Bell, 23, Waterloo Place, Edinburgh.
The two chairs adjacent to the joint are connected by a girder-like part, formed in a piece with them, and having its upper surface shaped to the contour of the under part of the

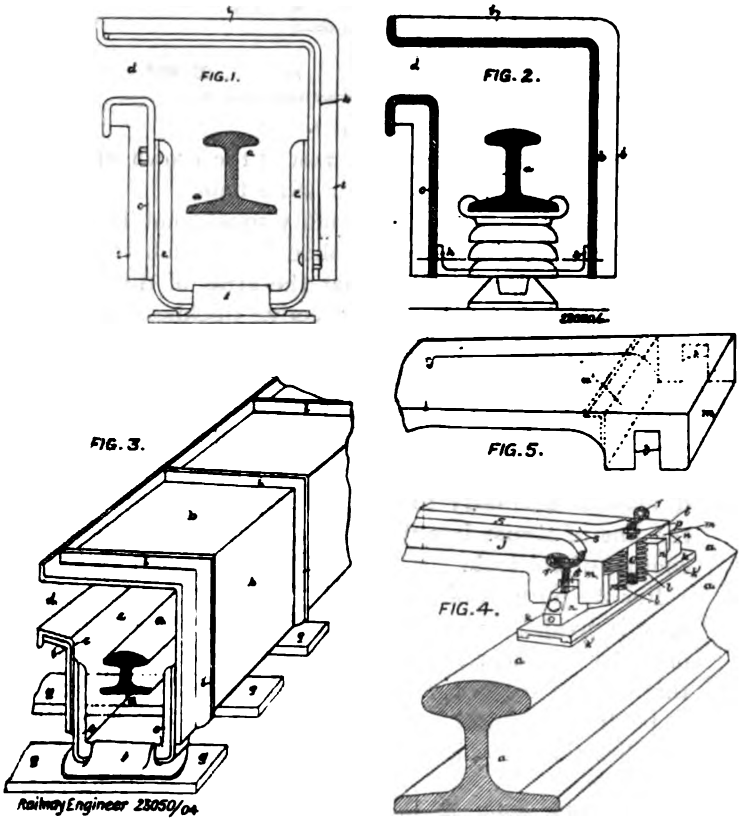


rail, so as to form a continuous bed for the rail, between the adjacent chairs. The fish-plates have vertical parts fitting the contour of the sides of the rail, and parts extending laterally outwards so as to encounter ribs, formed upon the upper face of the girder part, and which form lateral supports for the fish-plates and so for the rails. As the lateral extensions of

the fish-plates rest upon the upper surface of the girder part, vertical support is given to the rails as well as lateral support afforded by the engagement of the extensions with the ribs on the girder part. The fish-plates are secured to the rails in the usual manner by bolts passed through them and through the webs of the rails. Owing to the support afforded the fish-plates by their bearing vertically on the upper surface of the girder part, and laterally upon the ribs, the strains which come upon the bolts are reduced. The fish-plates may be of such a length as to extend nearly from chair to chair, and their ends may be arranged to abut against the parts formed on the chairs or on the girder part, and so prevent endwise or "creeping" movement of the rails. In order to strengthen the girder part, it may be formed with a depending web or webs upon its under side. Or ordinary fish-plates may be used, and the ribs on the girder part be dispensed with. A cushion of rubber or felt may be inserted between the girder part and the rails, and the chairs may be arranged to accommodate check rails. *(Accepted 1st December, 1904.)*

Electric Railways. 23050. 26th October, 1904. O. S. Gill, Lake House, Woolton, Liverpool.

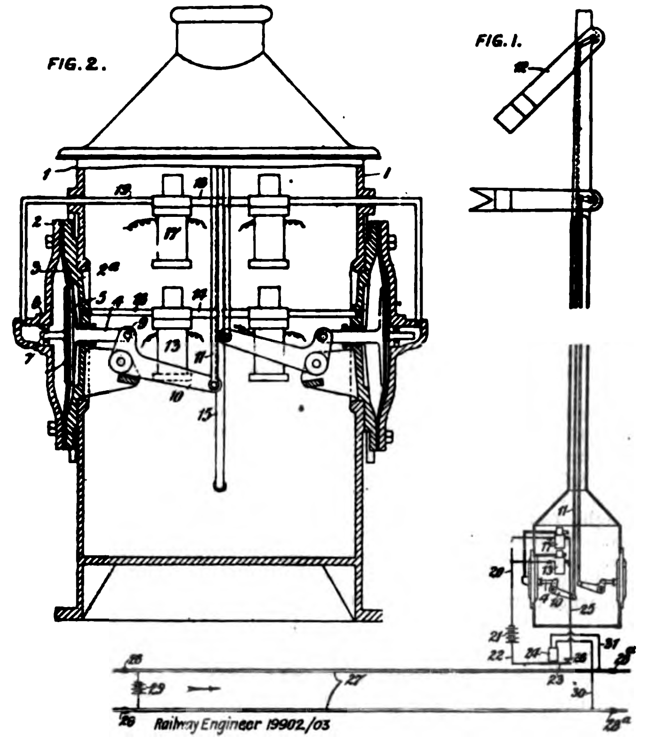
This invention relates to a covering or protecting device for live rails, and a current collector for use with the covering. The casing consists of **L** or **U** section lengths *b c*, the larger, *b*, covering and protecting the whole of the top and one side of the rail *a*, whilst *c* covers the other side of the rail, a gap or opening *d* being provided at the side, through which the arm carrying the collector passes. Between the collecting shoe *k* and arm *j* springs *l* are interposed, for the purpose of constantly maintaining the part k^1 on the rail *a*. At the free end of the collector arm the sides and end are flanged forming, with the piece m^1, a box or case *m*, this being open at the



lower side. Vertical slots *t* are provided in the ends of the case *m* into which **T** shaped projections *n* on the collecting shoe *k* fit. These **T** pieces form part of the casting *k*. The shoe *k* is therefore free to move in a vertical direction, and is maintained in contact with the upper surface of the conductor rail by the springs *l*. The collector shoe *k* is prevented from descending too far by means of a bolt or pin *o* fixed to the shoe and passing through a hole in the collector arm end *m*, a stop *p* being provided on *o* to regulate the amount of downward motion of the shoe. A renewable portion k^1 on the shoe *k* is maintained in position by studs *q*. The electrical connection between the motors and the collecting shoe *k* is formed by flexible insulated conductors *r* carried on the collector arm by a casing *s*, and being secured to terminals provided on shoe *k*. *(Accepted 1st December, 1904).*

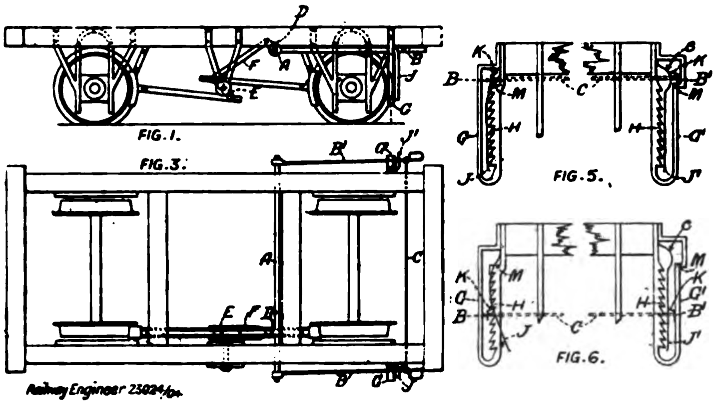
Signalling, Automatic. 19902. 15th September, 1903. E. C. Irving and J. P. O'Donnell, Palace Chambers, 9, Bridge Street, Westminster.

With this invention fluid pressure is admitted alternately to either side of a piston or diaphragm that operates the signal, the admission of the fluid pressure being controlled through valve devices operated by a train or vehicle entering or leaving an insulated section of the track comprising an electric track circuit, or by the train operating electric treadles or other means of sending a power impulse to the controlling valves. Where an electric track circuit is employed for controlling the operations of the signal two electrically controlled valves are provided, one of which normally admits fluid pressure to the piston or diaphragm for retaining the signal in the normal position (safety or danger as the case may be), the other valve cutting off the fluid pressure from the opposite



side of the piston or diaphragm and opening it to exhaust. If a train or vehicle enters on the insulated track section, or operates the treadle, the electric circuit is broken or made, through the magnets of the valves whereby the valve that normally admits fluid pressure to the piston or diaphragm, to hold the signal arm in the normal position, is operated to cut off the fluid pressure supply from that side of the piston or diaphragm and open it to exhaust, and at the same time the other valve is operated to admit fluid pressure to the other side of the piston or diaphragm whereby the signal arm is operated from the normal position to the opposite or danger position. The signal is held in this position until the train leaves the insulated track section, whereby the circuit that operates the valves is again made or broken and the valves are operated respectively to admit fluid pressure to one side of the piston or diaphragm and to exhaust it from the other side whereby the signal arm is returned to the normal position. The electrically controlled valves may be as set forth in the prior Specifications of Letters Patent Nos. 3078 of 1903 and 6553 of 1901 with suitable pipe connections from the main fluid pressure supply pipe to the valves and from the valves to the cylinder or diaphragm casing. Pneumatically operated valves may be employed in place of the electrically worked valves. *(Accepted 21st July, 1904.)*

Brakes, Wagon. 23024. 26th October, 1904. T. P. Poole, 10, High Street, Eastleigh, Hants.
The brake levers B B[1] are mounted on a transverse shaft A provided with an arm D which is connected by a pull rod F with the ordinary tumbler E. A cross bar C connects the



outer ends of the levers B B[1], thus enabling them to be raised or depressed simultaneously, whilst springs J J[1] on the guards keep the levers out of contact with the racks, either spring being easily pushed aside to allow the lever to engage. *(Accepted 1st December, 1904).*

SPECIFICATIONS PUBLISHED.

1903.

23387. Steps for tramcars and like vehicles; Stanley and Anger. 23715. Apparatus for electrically operating signals and points; Boddam. 23948. Electric tram cars; Conaty. 24740. Manufacture of rails, crossings, points and frogs; Hadfield. 24819. Signalling; Phillips. 24847. Electro-mechanical automatic switches for surface contacts for electric traction, also applicable for automatic signalling on railways; Waggott, Rosenburg and Smyth. 25173. Axle boxes for wagons; Steurs-Micheroux. 25179. Rail chairs; Gelder and Gelder. 25316. Wheels; Ellis and Ashworth. 25970. Current collector for stud contact systems of electric traction; Griffiths and Bedell. 26056. Valves, cylinders and fittings for vacuum brakes; Gresham, Gresham and Kiernan. 26124. Controlling and operating points of electric railways and tramways; Stewart, Turner and Dixon. 26250. Car couplings; Kuhlmann. 26557. Couplings; Gouldie. 26677. Locomotive fire-boxes; Preston and Rogers. 27069. Apparatus for operating points on electric tramways and light railways; Cardell. 27822. Wheels; Walker and Brancker. 27854. Method of operating tramway point shifters from cars; Cooley. 28032. Rails for permanent way; Bigwood. 28612. W.C's. and Urinals for railway carriages, &c.; Twyford. 28648. Apparatus for cutting off the wearing portions of compound tramway rails; Rhodes.

1904.

31. Wagon brakes; Morgan. 351. Safety device for use on electric vehicles on the stud contact system; Griffiths and Bedell. 399-400. Rail chairs; Bidder and Railway and General Engineering Co., Ltd. 772. Switches or points for railways or tramways; Smith. 1403. Railway and tramway frogs or crossings; Hadfield. 1562. Fog signalling apparatus; Templeman, Gough and Nicholls-Pratt. 1819. Apparatus for simultaneously locking doors of trains in motion; Pool. 2123. Lock nuts; Dadley and Dadley. 2125. Rail chairs; Bell. 2448. Brakes; Macaulay and Pattinson. 2449. Emergency brakes for electrically propelled vehicles; British Thomson-Houston Co., Ltd. (General Electric Co) 4690. Mono-rail traction; Faroux. 5010. Axle-boxes; Morgan. 8186. Brakes (Wagon); Framptons. 9463. Permanent way; Bryant. 10805. Points and switches; Murphy. 10830. Material for applying lubricant to axles; Laycock. 14754. Crossings; Howorth (Rhodes and Taylor). 15869. Electrically operating points; Siemens Bros. and Co. Ltd. (Siemens and Halske and Akt—Ges). 17959. Rail fastenings; Grange. 18228-9. Collapsible vestibules; Wood. 18322. Electric lighting of trains; Pieper and L'Hoest. 18561. Protector for live rails of electric railways; Linkleter. 18764. Couplings (Automatic); Beard. 19171. Rail spikes; McDermott. 20945. Permanent way; Ervin. 21102. Nut locks; Hughes. 21916. Couplings; Greeley. 22105. Buffers; Gatwood and Willans. 22272. Window lifts; Laycock. 22703. Apparatus for operating tramway and railway points, switches, &c.; Lewis. 23024. Wagon brakes; Poole. 23050. Electric railways; Gill.

The Strength and Stability of Stone and Brick Bridges.—II.

(Continued from page 357, Vol. XXV.)

It is obviously necessary next to ascertain the form of the curve of thrust, and, as the proportion of rise to span is constant, it is immaterial whether it is worked from the loads on the voussoirs or from those on the central part of the structure; as the latter are the heavier they will be used, the higher figures allowing of greater accuracy in plotting the triangles of force than the lower.

The line of thrust and the method of determining it are shown in fig. 3. The load per lineal foot of span is taken as

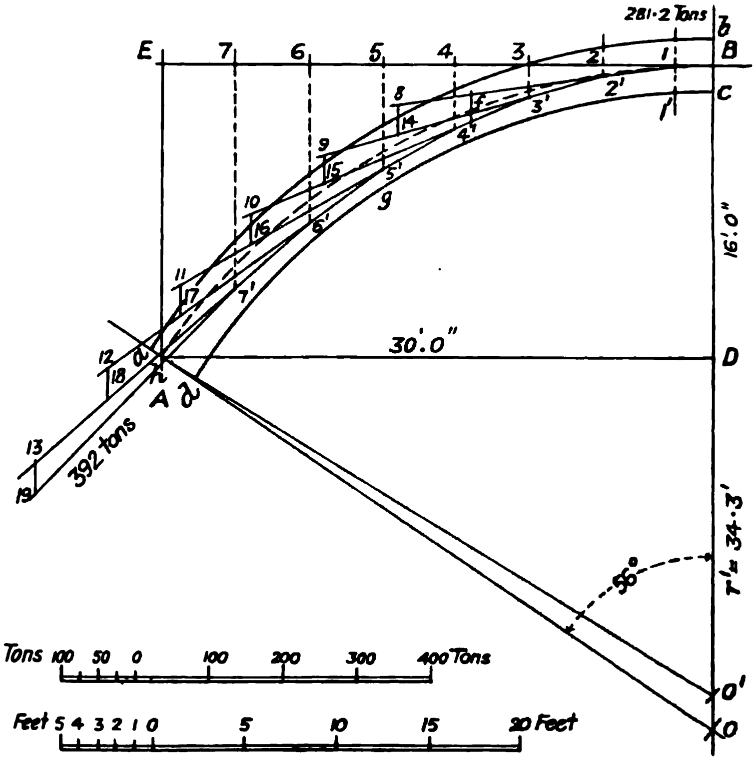


Fig. 3.

ten tons, and the horizontal thrust at the crown of the arch has been found (p. 357) equal to 281·2 tons.

The factor of safety for stability should not be less than two, for if the line of thrust should approach too near the edge there is a possibility that the arms of the stone may chip off, and thus reduce the effective thickness of the arch. To insure this factor of safety the line of thrust must be kept within the middle half of the thickness of the arch.

In the diagram, fig. 3, let *B A* represent the line of thrust, *A D* the effective springing line, and *D B* the rise of the arch.

The arch elevation has been struck from the centre *O*, but it may be necessary to slightly vary this in order to bring the line of thrust into the desired position in respect to the contour of the arch.

For the purpose of setting out the curve of thrust the half span is divided by imaginary lines into four feet lengths, each of which will therefore represent a vertical load of 40 tons; through the centres of gravity of these four foot lengths are to be drawn vertical lines, 1 . . 1'; 2 . . 2'; &c. to 7 . . 7', in the direction of which the vertical loads may be considered as acting.

From the point *B*, in the centre of the thickness of the arch at the crown, draw the horizontal line *B E*, and number the intersections with the vertical lines of load as shown. Now, at the point of intersection 1, two forces come into operation, the horizontal thrust 281·2 tons, and a vertical load of 40 tons. On the line *B E* and from the intersection 1, mark off 1 *e* = 281·2 tons on the scale of stresses, and from the point *e* draw the vertical line *e f* = 40 tons, and join 1 *f*; then in the triangle of stress 1 *e f*, 1 *f* will represent in direction and intensity the thrust between the points 1 and 2'.

Produce the straight line $1f$ to 8, making $2'\,8 = 1f$, and from 8 let fall a vertical line $8 \ldots 14 = 40$ tons, and join $2' \ldots 14$; then $2' \ldots 14$ is equal to the thrust between $2'$ and $3'$.

Produce $2' \ldots 14$ to 9, making $3' \ldots 9 = 2' \ldots 14$, and let fall the vertical line $9 \ldots 15 = 40$ tons, and join $3' \ldots 5$, which will represent the thrust between the points $3'$ and $4'$.

Continuing this process with the remaining loads, the thrusts are found up to the abutment *a d*.

The lines *B* 1, 1–2′, 2′–3′, 3′–4′, 4′–5′, 5′–6′, 6′–7′ and 7′–19 form a series of tangents to the true line of thrust, which must be wholly in the middle half of the thickness of the arch.

The horizontal thrust impinges centrally at *B* midway between the extrados at *b* and the intrados *a* and *c*. The nearest approach of the line of thrust to the intrados is at a point marked *g*, so here will occur one limiting point beyond which the intrados must not pass.

The point *h* is the nearest approach of the line of thrust to the extrados, and *a h* must therefore not be less than one-fourth of the springing *a d*.

By raising the centre of curvature from *o* to *o′* the conditions of stability are satisfied. There is a very great increase of stress at the abutment; the last line of thrust 7′–19 scales 392 tons. If the arch is kept of the same thickness throughout, the area of brickwork at the haunch will be $26 \times 3 = 78$ sq. ft. The pressure per square foot would therefore be $292 \div 78 = 5$ tons.

From the figures on p. 357 it appears that if the thrust is taken as all carried on the parts of the arch immediately under the spandril walls, the factor of safety in respect to *cracking* of red brick is 5·8.

At the haunches of the stone facings of the arch taking the crushing resistance of the stone the factor of safety is 12, so all over the arch the strength is ample for the thrust to be sustained.

(To be continued.)

Railways and the Board of Trade.—II.*

(Continued from page 25.)

THE following are the requirements of the Board of Trade as to new works :—

1. The requisite apparatus for providing by means of the *Block Telegraph* system an adequate interval of space between following trains, and, in the case of junctions, between converging or crossing trains. In the case of single lines worked by one engine under steam (or two or more coupled together) carrying a staff, no such apparatus will be required.

2. *Home-signals and Distant-signals* for each direction to be fixed at stations and junctions, with extra signals for such dock or bay lines as are used either for the arrival or for the departure of trains, and starting signals for each direction at all passenger stations which are also block posts. On passenger lines all cross-over roads and all connections for goods or mineral lines and sidings to be protected by home and distant-signals, and as a rule at all important running junctions, a separate distant-signal to be provided in connection with each home-signal.

* No. I. appeared in the January issue.

Signals may be dispensed with on Single lines under the following conditions :—

(a) At all stations and siding connections upon a line worked by one engine only (or two engines coupled together) carrying a staff, and when all points are locked by such staff.

(b) At any intermediate siding connection upon a line worked under the train staff and ticket system or under the electric staff or tablet system where the points are locked by the staff or tablet.

(c) At intermediate stations which are not staff or tablet stations, upon a line worked under the electric staff or tablet system; siding, if any, being locked as in *(b)*.

3. *The Signals at Junctions* to be on separate posts or brackets, and the signals at stations, when there is more than one arm on one side of a post, to be made to apply—the first or upper arm to the line on the left, the second arm to the line next in order from the left, and so on; but in cases where the main or more important line is not the one on the left, separate signal posts to be provided or the arms to be on brackets.

Distant-signals to be distinguished by notches cut out of the ends of the arms, and to be controlled by home or starting signals for the same direction when on the same post. A distant-signal arm must not be placed above a home or starting signal arm on the same post for trains going in the same direction.

In the case of sidings a low short arm and a small signal light, distinguishable from the arms or lights for the passenger lines, may be employed; but in such cases disc signals are, as a rule, preferable.

Every signal arm to be so weighted as to fly to, and remain at, danger on the breaking of any connection between the arm and the lever working it.

4. The *Front Signal Lights* to be green for all-right and red for danger. *The Back Lights* (visible only when the signals are at danger) to be white.

5. *Facing Points* to be avoided as far as possible, but when they cannot be dispensed with they must be placed as near as practicable to the levers by which they are worked or bolted. The limit of distance from levers working points to be 200 yards in the case of facing points, and 300 yards in the case of trailing points on the main line or safety points of sidings.

In order to assure that the points are in their position before the signals are lowered, and to prevent the signalman from shifting them while a train is passing over them, all facing points must be fitted with *Facing Point Locks and Locking Bars*, and with means for detecting any failure in the connections between the signal cabin and points. The length of the locking bars to exceed the greatest wheel base between any two pairs of wheels of the vehicles in use on the line, and the stock rails to be tied to gauge with iron or steel ties. All points, whether facing or trailing, to be worked or bolted by rods and not by wires, and to be fitted with double connecting rods

6. *The Levers by which Points and Signals are worked to be Interlocked* and, as a rule, brought close together into the position most convenient for any person working them, in a signal cabin, or on a properly constructed stage. *The Signal Cabin* to be commodious, and *to be supplied with* a clock and with a separate block instrument for signalling trains on each line of rails. The point levers and signal levers to be so

placed in the cabin that the signalman when working them shall have the best possible view of the railway, and the cabin itself to be so situated as to enable the signalman to see the arms and the lights of the signals and the working of points. The back lights of signal lamps to be made as small as possible, having regard to efficiency. If, from any unavoidable cause, the arm and light of any signal cannot be seen by the signalman, they must, as a rule, be repeated in the cabin.

7. *The Interlocking* to be so arranged that the signalman shall be unable to lower a signal for the approach of a train until after he has set the points in the proper position for it to pass; that it shall not be possible for him to exhibit at the same moment any two signals that can lead to a collision between two trains, and that, after having lowered the signals to allow a train to pass, he shall not be able to move any points connected with, or leading to, the line on which the train is moving. Points also, if possible, to be so interlocked as to avoid the risk of a collision.

Home- or Starting-signals, next in advance of trailing points, when lowered, to lock such points in either position, unless such locking will unduly interfere with the traffic.

A distant signal must not be capable of being lowered unless the home and starting signals in advance of it have been lowered.

8. *Sidings* to be so arranged that shunting operations upon them shall cause the least possible obstruction to the passenger lines. *Safety-points* to be provided upon goods and mineral lines and sidings, at their junctions with passenger lines with the points closed against the passenger lines and interlocked with the signals.

9. When a junction is situated near to a passenger station, the *Platforms to be so arranged* so as to prevent, as far as possible, any necessity for standing trains on the junction.

10. The *Junctions of all Single lines* to be, as a rule, formed as double-line junctions.

11. The lines of railway leading to the passenger platforms to be arranged so that the engines shall always be in front of the passenger trains as they arrive at and depart from a station; and so that, in the case of double lines or of passing places on single lines, each line shall have its own platform. At terminal stations a double line of railway must not end as a single line.

12. *Platforms* to be continuous and not less than 6 ft. wide for stations of small traffic, nor less than 12 ft. wide for important stations; the *Descents at the Ends of the Platforms* to be by ramps and not by steps. Pillars for the support of roofs and other fixed works, not to be less than 6 ft. from the edges of the platforms. The height of the platforms above rail level to be 3 ft., save under exceptional circumstances, and in no case less than 2 ft. 6 ins. The edges of the platforms to overhang not less than 12 ins. As little space as possible to be left between the edges of the platforms and those of the footboards on the carriages. Shelter to be provided on every platform and conveniences where necessary. Names of stations to be shown on boards and on the platform lamps.

13. When *a station is on or near a Viaduct or Bridge*, a parapet or fence on each side must be provided, of sufficient height to prevent passengers, who may by mistake in the dark leave the carriages when they are not at the platform, from falling from the viaduct or bridge.

14. *Foot-bridges or Subways* to be provided for passengers to cross the railway at all exchange and other important stations. Staircases or ramps leading to or from platforms to be at no point narrower than at the top and the available width to be in no case contracted by any erection or fixed obstruction whatever below the top. At all stations where crowding may be expected the staircases or ramps to be of ample width, and barriers for regulating the entrance of the crowd at the top to be erected. If in such cases there are gates at the bottom, a speaking-tube or other means of communication between the top and bottom to be provided; and in all cases gates at the bottom of a staircase or ramp to open outwards. For closing the openings at the top sliding bars or gates are considered best. The steps of staircases to be never less than 11 ins. in the tread, nor more than 7 ins. in the rise, and midway landings to be provided where the height exceeds 10 ft. Efficient handrails to be provided on both staircases and ramps. In subways where ramps are used the inclination not to exceed 1 in 8.

15. *A Clock to be provided* at every station in some conspicuous position visible from the platforms.

16. No station to be constructed, and no siding to join a passenger line, on a steeper gradient than 1 in 260, except where it is unavoidable. When the line is double, and the gradient at a station or siding-junction is necessarily steeper than 1 in 260, and when danger is to be apprehended from vehicles running back, a catch-siding with points weighted for the siding or a throw-off switch to be provided to intercept runaway vehicles at a distance outside the home signal for the ascending line greater than the length of the longest train running upon the line.

Under similar circumstances, when the line is single, provision for averting danger from runaway vehicles to be made—

1. At a station in one of the following manners:—
   - (*a*) A second line to be laid down, a second platform to be constructed, and a catch siding or throw-off switch to be provided on the ascending line inside the loop points.
   - (*b*) A loop line to be constructed further down the incline than the station platform, with a similarly placed catch siding or throw-off switch.

2. At a siding junction in one of the following manners, except where it is possible to work the traffic with the engine at the lower end of the goods or mineral train, in which case an undertaking (see No. 35) to do so, given by the company, will be accepted as sufficient:—
   - (*a*) A similar loop to be constructed, as in the case of a station.
   - (*b*) Means to be provided for placing the whole train on sidings clear of the main line before any shunting operations are commenced.

17. *Engine Turntables* of sufficient diameter to enable the longest engines and tenders in use on the line to be turned without being uncoupled, to be erected at terminal stations and at junctions and other places at which the engines require to be turned, except in cases of short lines not exceeding 15 miles in length, where the stations are not of a greater distance than three miles apart, and the railway company gives an undertaking (see No. 35) to stop all trains at all stations.

Care to be taken to keep all turntables at safe distances from the adjacent lines of rails, so that engines, wagons or

carriages, when being turned, may not foul other lines, or endanger the traffic upon them.

18. Cast iron must not be used for *Railway Underbridges*, except in the form of arch-ribbed girders, where the material is in compression.

In the cast iron arched bridge, or in the cast iron girders of an overbridge, the breaking weight of the girders not to be less than three times the permanent load due to the weight of the superstructure, added to six times the greatest moving load that can be brought upon it.

In a wrought iron or steel bridge the greatest load which can be brought upon it added to the weight of the superstructure, not to produce a greater stress per square inch on any part of the material than 5 tons, where wrought iron is used, or 6½ tons where steel is used.

The engineer responsible for any steel structure to forward to the Board of Trade a certificate to the effect that the steel employed is either cast steel, or steel made by some process of fusion, subsequently rolled or hammered, and of a quality possessing considerable toughness and ductility, together with a statement of all the tests to which it has been subjected.

19. In cases where *Bridges or Viaducts are constructed wholly or partially of Timber*, a sufficient factor of safety, depending on the nature and quality of the timber, to be provided for.

20. It is desirable that *Viaducts should, as far as possible, be wholly constructed of Brick or Stone*, and in such cases they must have parapet walls on each side, not under 4 ft. 6 ins. in height above the rail level, and not less than 18 ins. thick. Where it is not practicable to construct the viaducts of brick or stone, and iron or steel girders are made use of, it is considered best that in important viaducts the permanent way should be laid between the main girders. In all cases substantial parapets with a height of not less than 4 ft. 6 ins. above rail level must be provided by an addition to the girders, unless the girders themselves are sufficiently high. On important viaducts, where the super-structure is of iron, steel, or timber, substantial outside wheel guards to be fixed above the level of, and as close to, the outer rails as possible, but not so as to be liable to be struck by any part of an engine or train running on the rails. In the construction of the abutments or piers which support the girders of high bridges and viaducts, cast-iron columns of small size must not be used. In all large structures a wind pressure of 56 lbs. per square foot to be assumed for the purpose of calculation, which will be based on the rules laid down in the report, dated 20th May, 1881, of the Committee appointed by the Board of Trade to consider the question of wind pressure on railway structures.

21. The upper surfaces of the wooden platforms of bridges and viaducts to be protected from fire.

22. All castings for use in railway structures to be, where practicable, cast in a similar position to that which they are intended to occupy when fixed.

23. The *Joints of Rails* to be secured by means of fish-plates or by some other equally secure fastening. On main lines and lines where heavy traffic may be worked at high speed, the *Chairs* not to weigh less than 40 lbs., but on branch lines, or lines on which the traffic is light, chairs weighing not less than 30 lbs. may be used.

24. *Chairs must be fastened* to the sleepers, at least partially, by iron spikes or bolts. With flat-bottomed rails, where there are no chairs, or with bridge rails, the fastenings at the joints and at some intermediate places to consist of fang or other through-bolts; and such rails, on curves with radii of 15 chains or less, to be tied to gauge by iron or steel ties at suitable intervals.

25. In any curve where the radius is 10 chains or less, a *Check-rail* to be provided.

26. *Diamond Crossings*, as a rule, not to be flatter than 1 in 8.

27. *Standing works* (other than a passenger platform) *must have a clearance* to the side of the widest carriage in use on the line 2 ft. 4 ins. at any point between the level of 2 ft. 6 ins. above the rails and the level of the upper parts of the highest carriage doors. This applies to all arches, abutments, piers, supports, girders, tunnels, bridges, roofs, walls, posts, tanks, signals, fences, and other works, and to all projections at the side of a railway constructed to any gauge.

28. The *Space between adjacent Lines* or between lines of rails and sidings not to be less than 6 ft. Where additional running lines of rails are alongside the main lines, an interval of not less than 9 ft. 6 ins. to be provided if possible between such additional lines and the main lines.

29. At all *Level Crossings* of public roads the gates to be so constructed that they may be closed either across the railway, or across the road at each side of the crossing, and a lodge, or, in the case of a station, a gate-keeper's box, to be provided, unless the gates are worked from a signal cabin. The gates must not be capable of being opened at the same time for the road and the railway, and must be so hung as not to admit of being opened outwards towards the road. Stops to be provided to keep the gates in position across the road or railway. Wooden gates are considered preferable to iron gates, and single gates on each side to double gates. Red discs or targets must be fixed on the gates, with lamps for night use; and semaphore signals in one or both directions, interlocked with the gates, may be required. At all level crossings of public roads or footpaths, a footbridge or a subway may be required.

At occupation and field crossings the gates must be hung so as to open outwards from the line.

30. *Sidings connected with the Main Lines near a Public Road Level-crossing*, to be so placed that shunting may be carried on with as little interference as possible with the level crossing; and, as a rule, the points of the siding to be not less than 100 yards from the crossing.

31. At public road level crossings in or near populous places, the lower portions of the gates to be either close barred or covered with wire netting.

32. *Mile posts*, half-mile, and quarter-mile posts and gradient-boards to be provided along the line.

33. Tunnels and long viaducts to be in all cases constructed with refuges for the safety of platelayers. On under-bridges without parapets handrails to be provided. Viaducts of steel, iron, or timber to be provided with manholes or other facilities for inspection.

34. *Continuous brakes* (in accordance with the Regulation of Railways Act of 1889) complying with the following requirements to be provided on all trains carrying passengers, viz.:—

(1) The brake must be instantaneous in action and capable of being applied by the engine driver and guards.

(2) The brake must be self-applying in the event of any failure in the continuity of its action.

(3) The brake must be capable of being applied to every vehicle of the train, whether carrying passengers or not.

(4) The brake must be in regular use in daily working.

(5) The materials of the brake must be of a durable character, and easily maintained and kept in order.

35. Any undertaking furnished by a railway company to be under the seal, and signed by the Chairman and Secretary of the company.

(To be continued.)

Private Owners' 10-ton Tank Wagons.

THE standard specifications which have been settled by the Clearing House Committee to regulate the construction of private owners' wagons, include specifications for tank-wagons. By the kindness of Mr. James Holden, M.Inst.C.E., locomotive, carriage, and wagon superintendent of the Great Eastern R., and chairman of the above-mentioned committee, we are able to publish the drawings and specification for the 10-ton tank wagon. (The drawings of the details will appear our next issue).

These wagons follow the same general rules as other private owners' wagons, and the tank may be constructed so as to best suit the requirements of the particular trader, provided the "dimensions comply strictly with all the provisions and requirements set forth in the specification" below.

The registration plates and other conditions are the same as for open wagons; these we have previously published.*

Principal Dimensions.

1. The length of tank outside not to exceed	17 ft. 5 ins.
The diameter " "	3 ft. 8 ins.
The length over headstocks to be ...	18 ft. 0 ins.
Height of buffers from rail (unloaded) ...	3 ft. 5 ins.
Centres of buffers apart	5 ft. 8½ ins.
Wheel base not to be less than 9 ft. 6 ins., nor to exceed	10 ft. 6 ins.
Diameter of wheels on tread not to exceed	3 ft. 2 ins.

Tare.

2. Tare not to exceed 8 tons.

Tank.

3. The tank is to be of the form shown on drawings herewith, and is to be provided with wash and stay plates. The barrel to be made of ¼ in. and the ends of ½ in. Siemens' steel plates. The manhole at the top of tank to be provided with cover, pressure bar, and screw, so as to render the tank air-tight when the cover is closed. A horizontal bar indicating the level to which the tank may be filled is to be placed across the tank below the manhole at a height of 5 ins. from the crown of the tank, as shown on the drawing. The cover to have the following inscription cast upon it: "Tank must not be filled above bar below manhole."

The tank to be secured to the underframe by one of the methods shown on standard drawings, or any other approved design, a drawing of which must be furnished.

The outlet at the bottom to be provided with a malleable iron flanged funnel, fitted with a plug, the lower end of the funnel to be fitted with a brass cock securely bolted on. The plug to be raised and lowered by means of a lever and screw, worked by a small wheel at the top of the tank, and placed inside the manhole.

* The *Railway Engineer*, October, 1903. A list of the particular liquids permitted to be carried in these tank wagons will be found in the general railway classification of goods specification.

Painting of tank.

4. The tank to be painted red and all writing to be in white.

Underframe.

5. The underframe to be of steel or wrought iron of approved quality (*vide* attached specification*) and to the general design shown on the drawing.

The minimum dimensions of the principal members are as follows:—

Headstocks, solebars, and tank side supports ...	10″ × 3½″ × ⅜″ channel bars.
Trimmers	6″ × 3½″ × ½″ "
Middle bearers, diagonals, and longitudinals ...	9″ × 4″ × ½″ angle bars.
Tank end support angles	3″ × 3″ × ½″ "
" " supports ...	39″ × 13″ × ¾″ plate.
" side brackets ...	48″ × ¾″ plate.

The whole to be so prepared that the ends have a good bearing upon the adjacent parts.

Quality of wrought iron.

6. All wrought ironwork in the tank and underframe, and all pertaining or attached thereto (except the draw-gear), to be made of iron or mild weldable steel, to the specification attached.*

Draw-gear.

7. The draw-gear throughout to be made of the best cable iron, or mild weldable steel, of Government chain proof quality, and to be continuous and elastic; and of the dimensions shown on the standard drawings. The chains to be made of 1⅛ in. diam. iron or steel, and to hang loosely in the drawbar; all links to be welded at the side. Pins and shackles are not to be used.

Axle-guards.

8. The axle-guards to be made of 4 ins. × ¾ in. iron, and the wings to be 2½ ins. × ¾ in.; the bottom stay or bridle to be 2 ins. × ⅝ in. The axle-guards to be fastened to the frame by ⅞ in. rivets.

Bolts and nuts.

9. All bolts and nuts to be screwed to Whitworth standard thread, and, wherever possible, all nuts and cotters must be placed outside, so as to be easily seen if working off.

Brake.

10. Each wagon to be fitted with an approved brake, having a block applied to one wheel of each pair; also safety loops for preventing the brake-work from falling.

Buffers.

11. Laminated buffing springs are to be used; the buffers to be 18 ins. long from headstock to face, which is to be 13 ins. diam.; the buffer guides to be not less than 10 ins. long.

Buffing springs.

12. The buffing springs to be made of 12 plates of 3 ins. × ½ in. steel, and to be tested at the maker's works by an inspector, strictly in accordance with the specification in clause 19 (*vide* Appendix to this specification).* The spring buckle must be made of forged iron or steel; or in accordance with the method shown in the accompanying drawing.

Bearing springs.

13. The bearing springs to be made of either 5 plates 4 ins. × ⅝ in. steel or 8 plates 4 ins. × ½ in. steel; to have a wrought iron hoop 3 ins. × ½ in., and to have ½ in. rivet in

* This was published in the *Railway Engineer* for October, 1903.

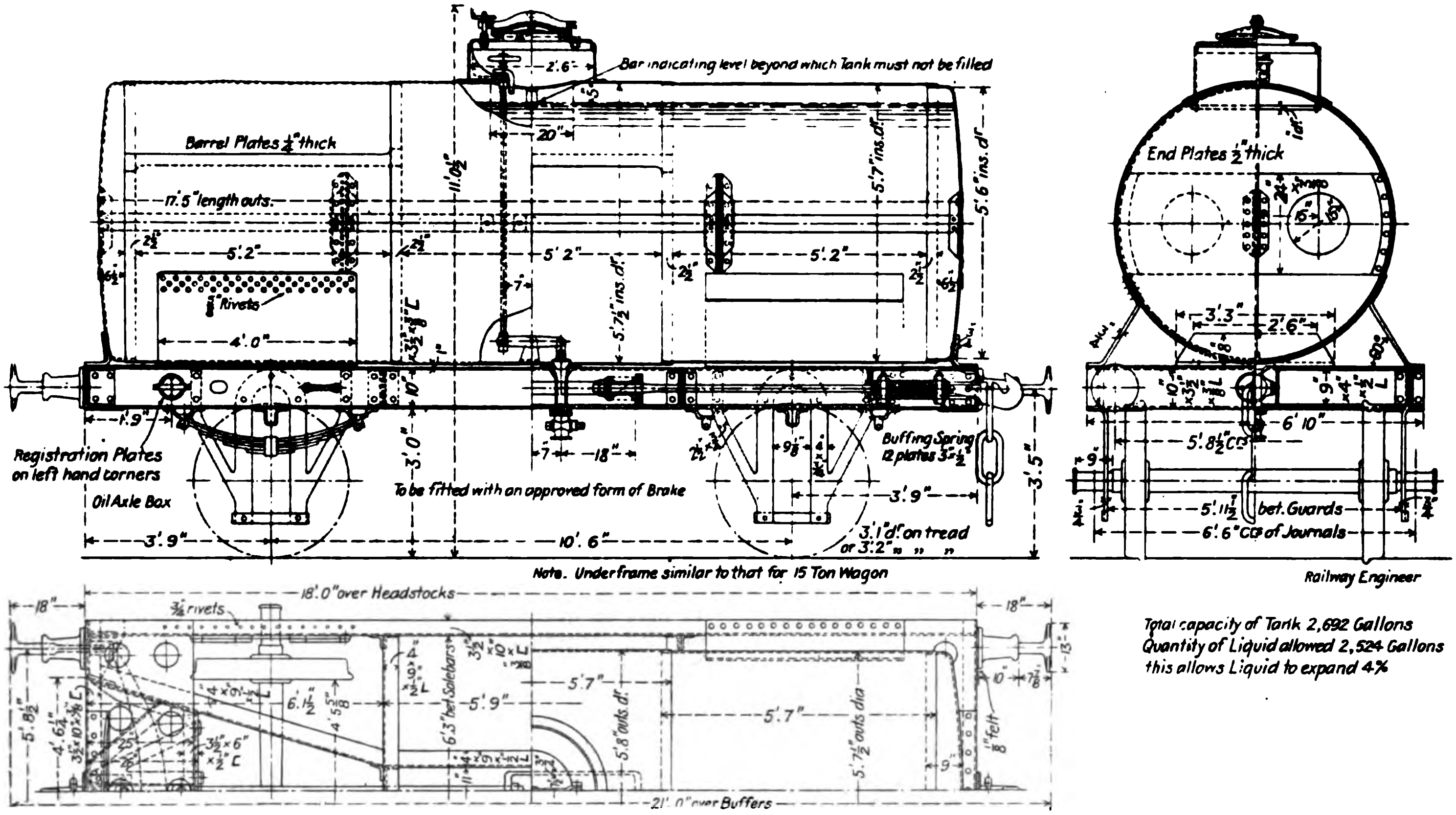


Fig. 1. 10-Ton Private Owners' Tank Wagon.

middle, or flat rivet of equal strength may be used if preferred. Cambre for 5 plated springs 4 ins. × 5/8 in. to be 6 1/2 ins., and for 8 plated springs 4 ins. × 1/2 in. to be 5 1/2 ins.

They shall be made to the standard drawings and be tested at the maker's works by an inspector, strictly in accordance with the specification in clause 19 (*vide* Appendix).

Tyres.

15. The tyres to be of Bessemer or Siemens' steel, and to be subjected to the tests set forth in clause 20 (*vide* Appendix).

The tyres to be 5 ins. wide, and not less than 2 ins., nor more than 2 1/2 ins. thick on tread when finished, truly bored out, with not more than 1/16 in. for contraction, and secured to

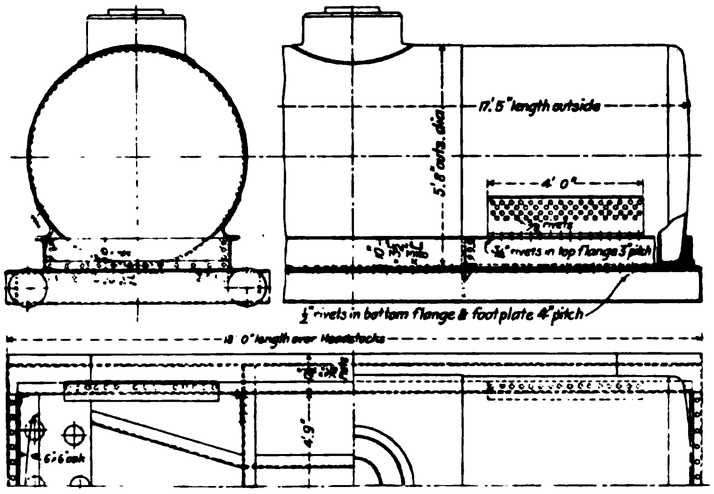


Fig. 2.

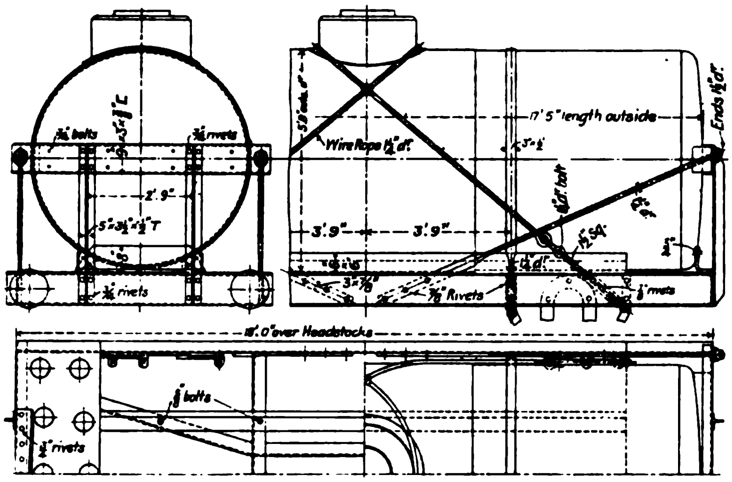


Fig. 3.

Alternative Methods of Securing Tank to Frame, 10-Ton Private Owners' Tank Wagon.

The bearing springs to be secured in position by bolts and nuts, as shown in standard drawings.

Axle-boxes.

14. Oil axle-boxes are to be used. They are to be cast of good strong iron or steel, or may be made of pressed steel, are to have brass or bronze bearings well fitted in, and must be to an approved design. The top of the box to be so formed that the bearing spring will bed into it 2 ins.

An efficient shield is to be put in the back of the box to keep out dust.

the wheels by one of the several approved modes of fastening shown in the standard drawings; but neither rivets nor bolts to be passed through or into the tyre.

Axles.

16. The axles to be made of Bessemer or Siemens' steel, and to be subjected to the tests set forth in clause 20 (*vide* Appendix). Wrought iron axles may be used if preferred, subject to the tests set forth in clause 21 (*vide* Appendix).*

The axles to be 6 ft. 6 ins. long from centre to centre of journals, 5 3/4 ins. diam. through the boss of the wheel, and

* This was published in the *Railway Engineer* for October, 1903.

gradually tapered to 5 ins. in the middle. There must be no shoulder on the axle behind the boss. The journals to be 9 ins. long × 4½ ins. diam., and the whole strictly in accordance with the standard drawing.

4½ in. journals must be taken out when worn under 4 ins.

Wheels.

17. The body of the wheel to be made of wrought iron of good marked bar quality, with either solid or open spokes, and wrought iron bosses. The bosses to be 7 ins. through and 10 ins. diam. The rim or periphery to be not less than 1½ in. thick, soundly welded throughout, and turned exactly to 2 ft. 9 ins. diam., and in section equal in strength to the form shown on the standard drawing. The boss to be bored out, and the wheel forced on to the axle by hydraulic pressure of not less than 50 tons. No keys are to be used.

If preferred the body of the wheel may be cast of steel of approved design.

Stamping of ironwork and steelwork.

18. All ironwork and steelwork to be stamped distinctly with the name or initials of the owner.

APPENDIX.

EXAMINATION AND TESTS OF BEARING AND BUFFING SPRINGS.

19. The bearing springs to be made in accordance with the standard drawing or pattern, and all springs to be of the best workmanship, closely fitted, and well tempered; the inspector will examine the springs as manufactured, and shall reject any he may consider defective in material or workmanship, or that do not stand the following tests:—

(*a*) Each bearing spring to be brought back under the scrag until the plates are quite straight, and then to resume its original cambre; and the back plate, when detached from the rest of the plates after scragging, to stand up to 5 ins. cambre.

(*b*) Each laminated buffing spring to be brought back under the scrag quite straight, and then to resume its original cambre; the back plate, when detached from the rest of the plates after scragging, to stand up to 12 ins. cambre.

(*c*) Each spring to be scragged without the buckle.

TESTING OF STEEL TYRES AND AXLES.

20. (*a*) Each tyre of the diam. of 3 ft. 1 in. to be guaranteed to stand without fracture the test of being compressed 4 ins. by hydraulic power, the compression to be continued until the tyre is broken. Also each tyre must be guaranteed to stand a tensile strain of not less than 35 tons per sq. in., with 25 per cent. of elongation; the test length to be 3 ins.

(*b*) The axles to be capable of standing the following test, without fracture, viz., five blows from a weight of 2,000 lbs. falling from a height of 20 ft. upon the axle, which shall be placed upon bearings 3 ft. 6 ins. apart, and turned after each blow. After the fifth blow the axle to be broken. Also each axle to be guaranteed to stand a tensile strain of not less than 35 tons per sq. in., with 25 per cent. of elongation; the test length to be 3 ins.

(*c*) The maker shall provide, at his own expense, one additional tyre and one additional axle in every fifty, or any less number ordered, to be selected from the bulk by the inspector, for testing in the manner above described, after which they shall be given up to the buyer, if required.

(*d*) The tyres and axles tested to be held to represent correctly the quality of the lots from which they are taken.

(*e*) Each tyre and axle to be stamped while hot, with the day, month, and year when made; and any tyre or axle failing before it has run 12 months, to be replaced at the expense of the maker.

(*f*) The maker's name and also blow or cast number to be well stamped upon each axle, and on the outer edge of each tyre.

TESTING OF WROUGHT-IRON AXLES.

21. (*a*) The axles to be capable of standing the following test without fracture, viz., five blows from a weight of 2,000 lbs. falling from a height of 20 feet upon the axle, which shall be placed upon bearings 3 ft. 6 ins. apart, and turned after each blow. After the fifth blow the axle to be broken.

(*b*) Also each axle to be guaranteed to stand a tensile strain of not less than 22 tons per sq. in., with not less than 25 per cent. of elongation; the test length to be 3 inches.

Rules for Automatic Signal Working.

It may be of interest and service to have the Standard Rules of the American Railway Association as to Automatic Signals.

They are as follows:—

Rule No. 501.

Home Signals.

Signal. colour.	Occasion for use. The signal will appear when	Indication for enginemen and trainmen.	Name, as used in rules.
(*a*) Red.	Block is not clear.	Stop.	Stop-signal.
(*b*) White.	Block is clear.	Proceed.	Clear-signal.

Where the semaphore is used the governing arm is displayed to the right of the signal mast, as seen from an approaching train, and the indications are given by positions:

Horizontal as the equivalent of (*a*).

Diagonal 60 below the horizontal as the equivalent of (*b*).

Where a single disc is used for two indications these are given by position of a "red" disc, as seen from an approaching train:

Disc displayed as the equivalent of (*a*).

Disc withdrawn as the equivalent of (*b*).

Distant Signals.

Signal. colour.	Occasion for use. The signal will appear when	Indication for enginemen and trainmen.	Name. as used in rules.
(*c*) Green.	Block is clear. Second block in advance is not clear.	Approach next home signal prepared to stop.	Caution-signal.
(*d*) White.	Home signal is at (*b*).	Proceed.	Clear-signal.

Where the semaphore is used the governing arm is displayed to the right of the signal mast, as seen from an approaching train, and the indications are given by positions:

Horizontal as the equivalent of (*c*).

Diagonal 60 below the horizontal as the equivalent of (*d*).

Where a single disc is used for two indications these are given by position of a "green" disc, as seen from approaching train:

Disc displayed as the equivalent of (*c*).

Disc withdrawn as the equivalent of (*d*).

502. Block signals control the use of the blocks, but, unless otherwise provided, do not affect the movements of trains under the time table or train rules, nor dispense with the use or the observance of other signals whenever and wherever they may be required.

503. Block signals apply only to trains running in the established direction.

504. When a train is stopped by a block signal it may proceed when the signal is cleared. Or it may proceed after waiting one minute and then running under caution.

505. When a signal is out of service the fact will be indicated by special bulletin notice.

Trains finding a signal out of service must, unless otherwise directed, proceed with caution to the next signal.

506. When a train is stopped by a signal, which is evidently out of order, and not so indicated, the fact must be reported to the superintendent and the signal engineer.

507. When signal masts located at junctions or diverging points carry three signals, the third or bottom signal marked "X" is the governing home signal for the diverging route.

508. When cars are placed on sidings they must be left far enough from the main track to clear the wooden splice blocks, otherwise the signal for that block will remain at stop.

509. Indicators are placed as follows:

(*A*). At all siding switches leading to the main track or at derails controlling movements to the main track.

(*B*). On the siding switch of all cross-overs leading from side track to main tracks.

(*C*). At each switch of a main track cross-over. In such cases the indicator at the switch in the east bound track relates to train movements on the west bound track, and the indicator at the switch in the west bound track relates to train movements on the east bound track.

510. The purpose of indicators is as follows:—

(*a*) To notify trainmen when a train is approaching.

(*b*) To notify trainmen when the block between any particular indicator and the next home signal is clear.

511. All indicators located in any particular block display a red disc from the time a train enters the second block back until it has passed out of the block in which the indicators are located. Indicator discs may be seen at night by using the hand lamp.

512. Trainmen opening switches must be governed as follows:

(*a*) No switch shall be opened without taking precaution for protection as prescribed by rules 99 and D 152.

(*b*) Immediately after the passage of any train at a switch, and while the rear end of such train is in sight, trainmen may open the switch while its indicator is red, provided precautions have been taken as prescribed by the train rules. In no case, however, must a train moving from a siding to the main track use a main track cross-over unless the indicator for the opposite track is clear.

(*c*) A train passing from one main track to the other or out of a siding while the indicator is red, must proceed as prescribed by rule 504.

513. Each switch leading to the main track and each switch in the main track is provided with switch instruments connected to the switch point in such a manner that the opening of any switch will hold the home signal of the block in which the switch is located at stop, and the corresponding distant signal at caution, until the switch is again closed.

The opening of a switch at either end of a main track cross-over holds the signals in both directions at stop in the same manner.

514. A train must not move over the wooden splice blocks in passing from a siding to main track until the person attending the switch has examined position of indicator and given the proper signal.

515. Numbers are placed on the mast of all automatic signals; trainmen may designate the automatic from all other fixed signals by these numbers.

516. Conductors must report to the signal engineer and to the superintendent of the division by wire from the next stopping place where there is an open telegraph office all delays caused by signals (except delays known to have been caused by a train in the block) giving the number of each signal at which the delay occurs.

517. Conductors, before reporting stops as "causes unknown," must in all cases ascertain from enginemen if such stops were caused by a train in the block or an open switch.

518. In foggy or stormy weather when signals cannot be seen plainly the signals must be approached cautiously so that enginemen and trainmen can see and interpret them correctly. Always bearing in mind that safety is of greater importance than making time.

Some explanation may be useful to readers on this side of the Atlantic.

Rule 502, as above worded, may be difficult to understand, but the interpretation is that the lowering of a signal is not to abrogate any instructions that may have been issued as to the running or movement of the train.

Rule 504 more certainly needs some explanation.

With non-automatic signalling no train may pass a starting or home signal at danger, for it is an indication to a driver that the signalman has not received an intimation that the section ahead is clear. And it has always been urged that behind the signal is the signalman's intelligence. But all this is different to an automatic signal that may be fixed miles from a signal-box, and which like all mechanical appliances is liable, though rarely, occasionally to failure. Therefore some provision has to be made against a driver waiting an indefinitely long period at a signal that is out of order. The American rule, which has been adopted on this side of the Atlantic too, is that a train must stand for one minute at a signal and may then go forward into the section "under caution," *i.e.*, prepared to stop at any point. On getting to the next signal if that is in work and "clear" he will resume ordinary running.

Rule 508 refers to "splice-blocks." These are insulated joints. In America safety points are not generally provided in sidings at the fouling point and the "splice-blocks" are fixed there so as to indicate that the train is "inside."

Rule 509. The indicators referred to in this Rule are those fixed at sidings to show whether the two sections in the rear and the section in advance is clear.

Rules 99 and D 152, referred to in Rule 512 (*a*), refer to the protection of a train by the flagman as is customary on American roads.

Rule 512. The second paragraph (*b*) allows a train to shunt out of a siding on to a line where a train has passed and is going forward, although the indicator for the advance section is showing red.

Rule 513. The caution position of the distant signal, referred to in this Rule, is the "on" position.

Rule 514 means that no train must leave the siding until the indicator has been examined.

Construction of a Concrete Railway Viaduct.*

The viaduct in question is situated at Cannington, on the Axminster and Lyme Regis Light Railway, which now connects Lyme Regis with the Yeovil and Exeter line of the London and South-Western Railway. It consists of ten elliptical arches of 50 feet span, its total length being 600 feet, width over spandrels 16 feet, maximum height to rail-level 92 feet, and gradient 1 in 80. It affords an example of the recent application of concrete to viaduct construction and to arches of somewhat large span. With the exception of the concrete blocks in the vertical faces of the arches, the work throughout is mass concrete.

The geological strata are greensand and blue lias clay. The foundations, originally designed for a pressure of 3½ tons per square foot, were enlarged to give pressures ranging from 1½ ton to 3 tons per square foot.

The concrete used consisted of crushed flints and Portland cement, the crushing yielding sufficient grit to make the addition of sand unnecessary except in special cases. The concrete was hand-mixed, and for transporting this and other

* Abstract of a Paper by Messrs. A. Wood-Hill and E. D. Pain, read before the Inst.C.E., December, 1904.

materials a cableway of 1,000 feet span was erected across the valley, the piers being built without scaffolding.

The piers were carried up in rectangular lifts of diminishing size, instead of having a continuous batter, the lifts being 6 feet deep. The concrete was deposited in wooden boxes of this depth, which were bolted up on the ground and hoisted into position. The mode of filling and striking the boxes, which there are eleven, is described. The work in all the piers was advanced as far as possible at the same rate.

Two rows of corbels were built in the top lift of the piers to support the arch-centering. This consisted of four built ribs, the centre portion of which was tied by a framework, in the form of a Warren girder, supported in the middle by raking struts from the lower row of corbels. The ribs, including the lattice-work, were set in one piece, and four tie-bolts were placed in the span to assist the piers in taking the thrust.

The faces of the arches were built in concrete blocks, of which two similar ones on opposite sides of the viaduct were set simultaneously by a rail attachment to the cableway; and by adjusting the chains attaching the blocks the latter were suspended at the angles required by their position in the arch. The blocks were keyed in advance of the mass concrete, in order that the adhesion of the latter to the toothing of the blocks might relieve the centres of some of the weight.

Expansion joints were formed through the arches, spandrels and parapets, and are found effective in giving play for expansion and contraction and any slight movement due to settlement. In turning the arches, the centering, although apparently light, was found to be sufficiently rigid, and the setting was facilitated by the ribs being made in one piece.

The settlement of the piers was for the most part fairly even, and, being adjusted as the work proceeded, did not affect the concrete; but the settlement of the west abutment and first pier was greater then elsewhere, and crushed the crown of the first arch. Two diaphragm-walls were built in brickwork in cement in the third span, to enable it to act as an abutment, and concrete needles were built in the embankment between the first and second piers; the crushed portion of the first arch was cut out and made good in brickwork, and the parapets over this arch were completed. Particulars are given of the cost of the viaduct, and a schedule is appended of the results of tests of sample blocks made from materials used in the concrete.

The Authors believe this is the first instance in which piers of a similar height have been built without scaffolding, and in which the centres of a 50-foot arch have been designed for setting in one piece.

Roaring Rails.

Mr. G. Moyle has collected such information as is available on this subject, and this, supplemented by notes from various sources, is published as Technical Paper No. 158. "Roaring" is caused by the development of furrows or corrugations across the running head of the rail, usually oblique to its length. Such rails do not in the least resemble galled or pitted rails.

Of the ascertained facts which are recorded, the most important seem to be that roarers are seldom found except where the road is packed *and boxed* with coarse brick or burnt clay, or on open girder bridges; that if the brick boxing be removed and replaced by earth, the trains tend to wear the rails smooth again; that the ridges resist the action of a file, and the metal in the hollows is soft, and in some cases cracks tend to develop, so that if the rail be inverted, or the position of the sleepers altered, there is risk of fracture; and that "roarers" taken out of the track, planed smooth and replaced, have again developed roaring.

Various suggestions which have been made as to the cause of roaring are enumerated; some of these are obviously incorrect, and most of them rather vague. The unequal distribution of the pearlite and ferrite in the metal, especially when the proportion of manganese is high, is one of the suspected causes, but as the areas of segregation are microscopic, this alone does not account for corrugations, the pitch of which varies between 0·50 and 1·14, with a mean of 0·74 inch and a mean depth of 0·0035 inch.

In a Note prepared in the office of the Director of Railway Construction it is stated that roarers develop from rails which when first laid were *flat*. Of the numerous statements in the Paper this is perhaps the most difficult either to prove or disprove. It is certainly exceptional for the head of any new rail to be absolutely flat, it is nearly always more or less marked by a series of shallow scratches, with corresponding ridges between them, produced by the rubbing of the flange of the rolls, in the last pass, across the head of the rail. This is noticed by the Executive Engineer, North-Western Railway, Karachi. The passage of the wheels over such a rail tends to produce alternate hard and soft places, the difference in hardness being greatest where the rails were originally comparatively hard, and least where they were comparatively soft. Any predisposing cause to vibration synchronous with the pitch of these hard and soft places will tend to accentuate the difference, the hard parts becoming harder and the softer metal being squeezed into the hollows; the action of rust will tend to further increase the inequalities. The hard and soft patches would in time extend down some depth into the head, which would account for a roarer becoming a roarer again after its head had been planed smooth. If the conditions are unfavourable to the production of vibration, the rail may be worn approximately even again before the difference in hardness becomes marked. Running over a new rail nearly always produces a harsh sound, which sooner or later generally ceases, a result probably produced by a change from a rough to a smooth (but not necessarily even) surface, during which the seeds of subsequent "roaring" are laid. This may not become noticeable or objectionable for some time, but the mere fact that it is not noticed is no evidence that the head of the rail is flat. It is not necessary to suppose that the original inequalities were at an approximately uniform pitch throughout the length of the rail; a few consecutive ones of about the same pitch would, under favourable conditions, tend to produce others of similar pitch on the rest of the rail.

Some clue might be obtained to the manner in which they are formed by tracing their exact outline with some device which greatly magnifies the inequalities. Such a method would probably show a distinct difference in form on single and on double line, and discover incipient corrugations on rails not classed as roarers.

This would throw some light on the progress of the disease, and might suggest some more satisfactory remedy than boxing with earth.—*Indian Engineering.*

Distribution of Electrical Energy.*

The paper deals first with the attitude of the Legislature towards the electrical industry, and recites some of the points of the 1882 Electric Lighting Act, which retarded the progress of electrical development. It then deals with the improved clauses under the 1888 Electric Lighting Act. Reference is made to the removal of restrictions upon undertakers which would be effected by the Electricity Supply Bill, promoted by the Board of Trade in the last Session of Parliament, and a hope is expressed that this will soon become law. Mention is also made of the falling-in of the leases of borough tramways, and the effect of electrical traction upon the output and load-factor of the generating station. The Author then describes the various systems by which electricity is at present distributed, including direct-current two- and three-wire distribution; direct-current high-tension generation, and low-tension distribution; single-phase, two- and three-phase currents, high-tension generation, and low-tension distribution; three-phase high-tension, and low-tension direct-current distribution.

After dealing with the limits of pressure as defined by the Board of Trade, and the results of the work of the Engineering Standards Committee in settling upon standard periodicities, the systems of supply are more thoroughly criticised, and the single-phase system is set aside as being inapplicable for general supply, as is also the direct-current high-tension system. The Author is of opinion that the distributing systems which are likely to be adopted in the future are:—

1. Direct-current, two- or three-wire, for small districts;
2. Single-phase high-tension for railways;
3. Two-phase high-tension generation and low-tension distribution (for existing single-phase systems of general supply);
4. Three-phase high-tension generation and direct-current low-tension distribution (for existing direct-current systems in large districts, and for railways of short length);
5. Three-phase high-tension generation and low-tension three-phase or six-phase distribution (for entirely new and large districts).

Diagrams accompanying the paper demonstrate the economical radii of supply by direct current at 500 volts for different loads transmitted and by the high-tension sub-station method, the result being that above the undermentioned distances the high-tension method is more economical, viz.:—

Kilowatts.	Economical radius.
250	1·6 mile.
500	1·25 „
1,000	1·06 „

With regard to the effect of storage at sub-stations, the Author believes that storage will be more largely resorted to in the future; and figures are given in support of this view. He then proceeds to discuss the economical limit of pressure for high-tension supply by underground cables, and gives curves to show that for general purposes, in Great Britain, 6,600 volts is, approximately, the economical pressure. The effect of the cost of insulation of extra-high-tension cables is also discussed. The paper next deals with the cost of overhead transmission of high-tension currents, and reasons for fixing upon a pressure of 20,000 volts in this country, are given.

As to the cost of supply, the ideal figure given by Colonel Crompton in 1894 is stated to have been surpassed. A new ideal figure is given by the Author, based upon further experience gained in the past 10 years; and he predicts the costs which are likely to be charged to various classes of consumer.

Turning to transmission-lines, a description is given of the practice adopted in extra-high-tension underground cables, and the risks which have to be guarded against. The mechanical and electrical construction of overhead lines for extra-high pressures is also dealt with.

The paper then enumerates various classes of sub-station, covering static transformers for three-phase low-tension distribution; static transformers with rotary converters for direct-current distribution; and synchronous or induction motor-generators for direct-current distribution at the higher periodicity. Descriptions follow of the various sub-stations erected by the Author, with curves of their outputs, and particulars of their efficiencies.

The various methods of distributing energy at low pressure are classed as follows:—

I.—*Conduit or Draw-in System.*

1. Bare-copper-strip systems, strained and unstrained.

2. Cables insulated by india-rubber, vulcanized bitumen, or other dielectrics drawn into stoneware casings, Callender-Webber bitumen casings, fibrous conduits, cement casings, and cast-iron or wrought-iron pipes.

II.—*Buried or Solid System.*

1. Vulcanized bitumen, dialite or other insulated single cables, laid in iron, stoneware, or wooden troughing, and surrounded by molten bitumen or pitch.

2. Concentric cables, paper insulated, and lead covered, laid in the same manner.

3. Single-phase or concentric cables, each protected by its own sheathing of steel tapes or wires, laid direct in the ground.

The relative merits of these systems are fully discussed, and a curve is given showing the respective capital costs of the systems.

The Author then deals with the systems of distribution adopted in tramway construction, and their relative advantages and disadvantages.

The question of fusing the general network, and the fixing of section-boxes is gone into fully; the Author deciding against fuses, except in concentric networks, and strongly advocating the use of section boxes for sub-dividing the network.

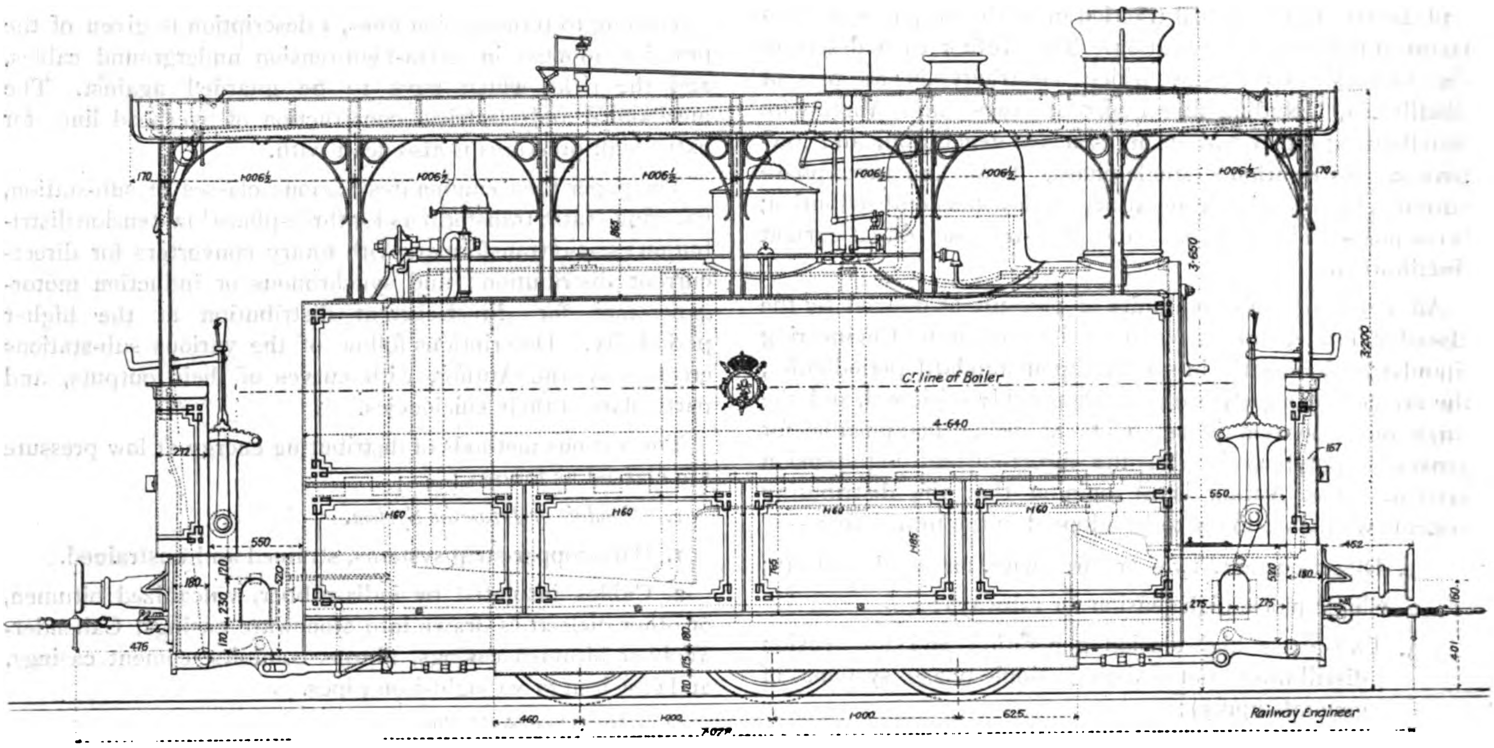
The paper concludes with some particulars of the supply of electrical energy to short and long-distance railways. The Author believes that a modification of the present third-rail system will remain with short-distance railways, and that improved methods in the application and control of single-phase currents will be adopted for long-distance railways.

*Abstract of a paper by Mr. John F. C. Snell, read before the Institution of Civil Engineers, November, 1904.

Rolling Stock for Belgian Light Railways.

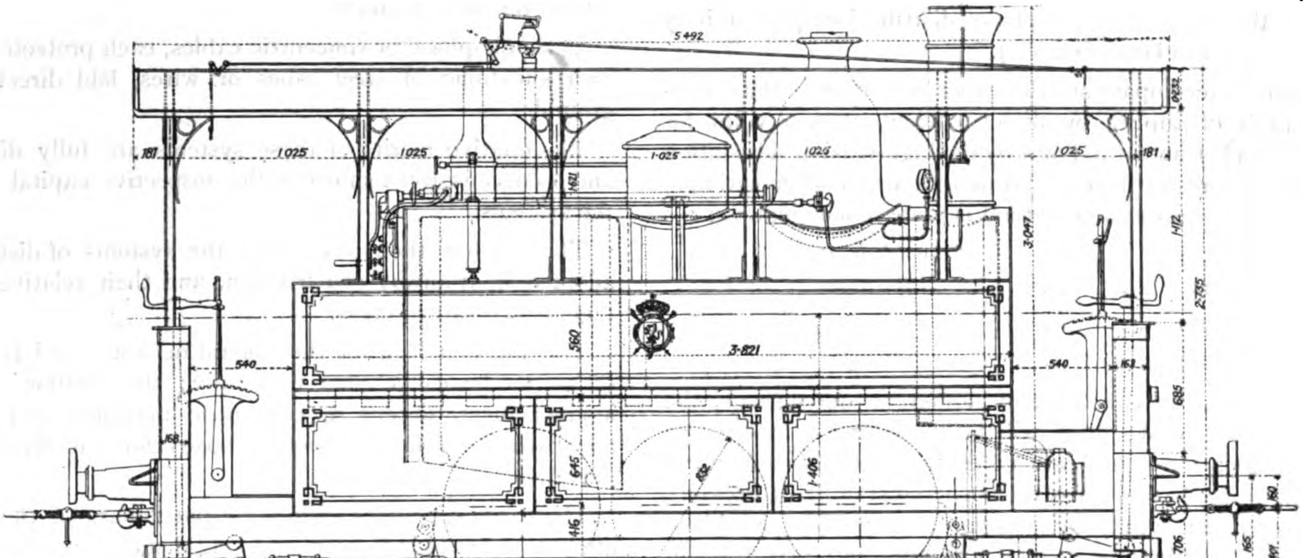
In our issue for last September we illustrated and described the permanent-way which has been adopted for the great system of successful light railways extending all over Belgium, and which is controlled by the *Soc. nationale des Chemins de Fer Vicinaux*. We are now able by the courtesy of *Mons.* C. de Burlet, *Directeur général* of the *Société*, to publish the annexed diagrams and particulars of the types of carriages and wagons which are used, and we hope to be able in a future issue to give some further details respecting them.

It will be noticed that the wheel base of most of the vehicles is given as 1·800 *m*, but this dimension refers to the older stock, as all the newer stock is being built with a wheel base of 2·400 *m*. The wagon illustrated on p. 59 is for transporting standard gauge rolling stock on their own wheels, and thus save the cost of transhipping the load.



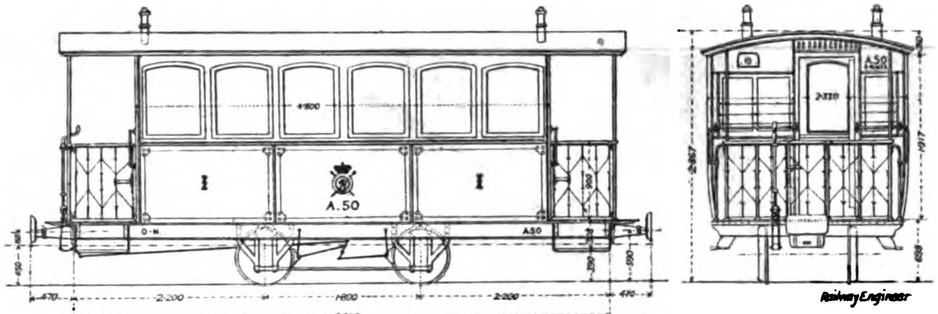
Locomotive, weight 27 metric tons, Société Nationale des Chemins de Fer Vicinaux.

Length over buffers	7·028	Height from rail to centre of buffers	561
Height from rail to top of chimney	3·650	" " " " draw bar	401
Length of tanks outside	4·640	" " " " boiler	1·610



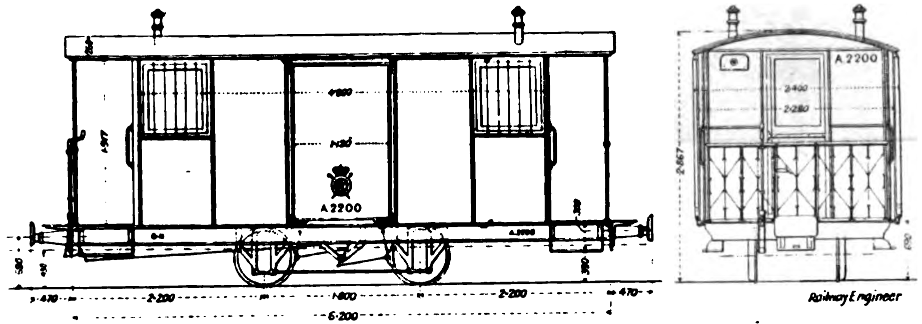
Locomotive, weight 18 metric tons, Société Nationale des Chemins de Fer Vicinaux.

Length over buffers	6·202	Height from rail to centre of buffers	561
Height from rail to top of chimney	3·047	" " " " draw bar	401
Length of tanks outside	3·821	" " " " boiler	1·406



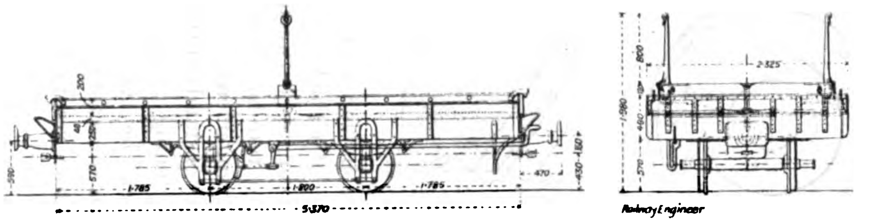
First-Class Carriage.

Wheel base	1·800	Length of body inside	4·656
Length over headstocks	6·200	Width of body inside	2·160
Length of buffers	0·470	Height between floor and roof bars ..	2·027
Height from rail to centre of buffers ..	0·590	Height on centre line from rails.. ..	2·867
Height from rail to centre of draw-bar..	0·430	Number of compartments	2
Length of body outside at waist ..	4·800	Number of seats inside	20
Width of body outside at waist	2·320	Weight of carriage .. (kilogs.)	4 090



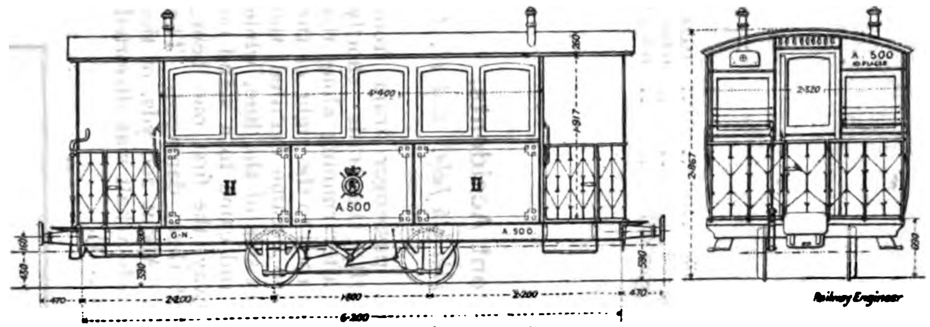
Baggage Van.

Wheel base	1·800	Width of body outside	2·210
Length over headstocks	6·200	Width of body, over side doors	2·400
Length of buffers	0·470	Length inside of mail compartment ..	1·745
Height from rail to centre of buffers ..	0·590	Width inside of mail compartment ..	0·650
Height from rail to centre of draw-bar..	0·430	Number of flap seats	3
Length of body outside at waist.. ..	4·800	Weight .. .. .. (kilogs.)	4,580



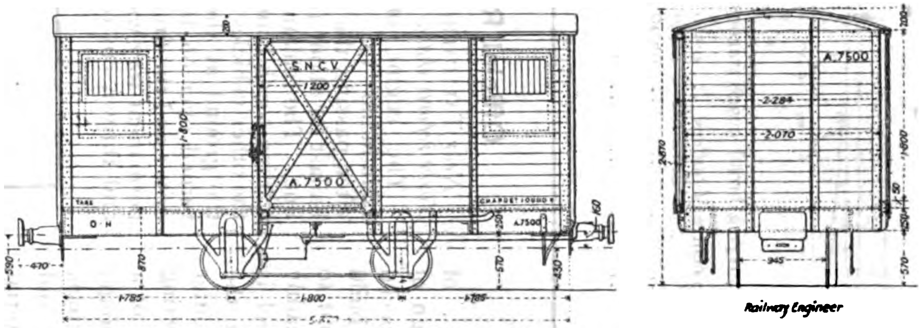
10-ton (metric) Platform Wagon.

Wheel base	1·800	Height of sides above floor	0·200
Length over headstocks	5·370	Thickness of floor	0·040
Length of buffers	0·470	Height of floor from rail	0·860
Height from rail to centre of buffers ..	0·590	Total height from rail	1·060
Height from rail to centre of draw-bar..	0·430	Width over all projections	2·326
Length of body inside	5·370	Capacity .. .. .. (kilogs.)	2,341
Width of body inside	2·180		



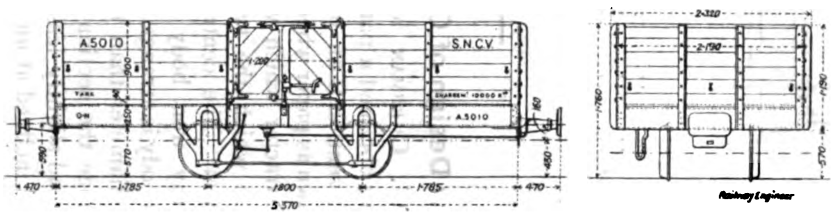
Second-Class Carriage.

Wheel base	1·800	Width of body outside at waist	2·320
Length over headstocks	6·200	Height on centre line above rails ..	2·867
Length of buffers	0·470	Length of body inside at waist	4·256
Height from rail to centre of buffers ..	0·590	Width of body inside at waist	2·160
Height from rail to centre of draw-bar..	0·430	Number of seats inside	24
Length of body outside at waist ..	4·400	Passengers carried on platforms ..	10



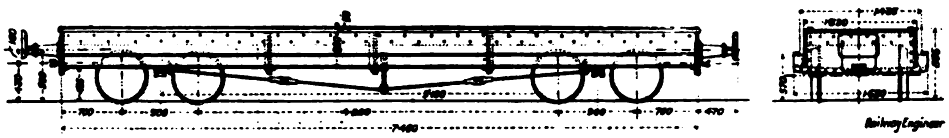
Closed Goods Wagon.

Wheel base	1·800	Total height from rail	2·870
Length over headstock	5·370	Width of sliding side doors	1·200
Length of buffers	0·470	Thickness of floor	0·050
Height from rail to centre of buffers ..	0·590	Thickness of partitions	0·025
Height from rail to centre of draw-bar..	0·430	Height of floor from rails	0·870
Length of body inside	5·320	Width between tyres	0·945
Width of body inside	2·020	Weight of load .. .. (kilogs.)	10,000



High-Sided Wagon.

Wheel base	1·800	Width of door openings	1·200
Length over headstocks	5·370	Thickness of floor	0·040
Length of buffers	0·470	Thickness of partitions	0·035
Height from rail to centre of buffers ..	0·590	Height of floor from rail	0·860
Height from rail to centre of draw-bar..	0·430	Total height from floor	1·760
Length of body inside	5·300	Width over all projections	2·320
Width of body inside	2·120	Capacity .. .. .. (kilogs.)	10,112
Height of sides from floor	0·900		

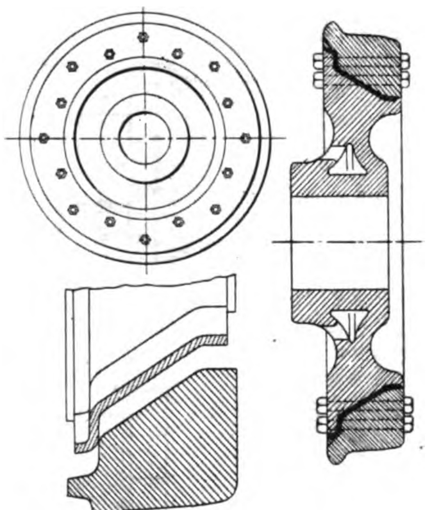


20-ton Wagon for carrying broad guage wagons.

Centres of bogies	5·100	Height from rail to centre of buffers ..	0·590	Gauge of tranship rails	1·435
Wheel base of bogies	0·900	" " " " draw bar	0·430	Height of tranship rail	0·600
Length over headstocks	7·400	Thickness of floor..	0·040	Maximum height from rail	0·855
Width over all projections	1.630	Height of floor from rails	0·855		
Length of buffers	0·470	Width of floor	1·330		

New Design of Car Wheel.

Messrs. Geo. W. Curfman and John W. Corts, of Cleveland, O., have obtained a patent upon a new design of car wheel. This invention is an improvement on the special type of wheels known as paper wheels, and its object is to build a wheel of this character which will run noiselessly, and to provide a wheel on which the tyre portion may be readily removed for renewal. The central portion of the wheel is composed of a gray iron body of a form shown in the illustration. This body is arranged with two flanges, the outer one being of less diameter than the inner one. Connecting with the outer flange the section of this body consists of a narrow, straight tread slightly less diameter than the flange, then a central tread inclined at an angle of about 32½ degrees, then the inner flange. The corners between the inclined and straight treads are rounded. The paper or cushioning material



is formed in a ring having a similar section to that of the wheel centre, and is of a thickness slightly greater than half the difference in diameter between the flanges and straight tread portions. The tyre has an interior surface of a similar section with no arrangement for the flanges. The exterior section of the tyre is of standard tyre section. In assemblying the wheel the cushioning material is put into place around the centre and then the tyre bolted on by horizontal bolts connecting through the cast iron centre and drawn up into place, which operation compresses the cushioning and forces part of it out between the flanges and the tyre. The general construction shows plainly in the illustration.—*The Railway and Engineering Review.*

Official. Reports on Recent Accidents.

Near Talycafn, L. & N. W. R., *on the 5th July. Col. H. A. Yorke reports that :—*

The engine of the 10.25 a.m. passenger train from Llandudno to Bettws-y-Coed left the rails shortly after passing the 7¼ mile post, and after running along the ballast for about 100 yds., was overturned to the right of the line. The remainder of the train also became derailed, the leading coach being upset on the right side of the line, while the other vehicles turned to the left, and came to a stand on the ground at the side of the railway, the first one being turned over on its side, and all of them damaged. The driver and the fireman were injured. About 200 yds. of the permanent way was damaged, of which a half was distorted and thrown out of alignment (see fig. 1).

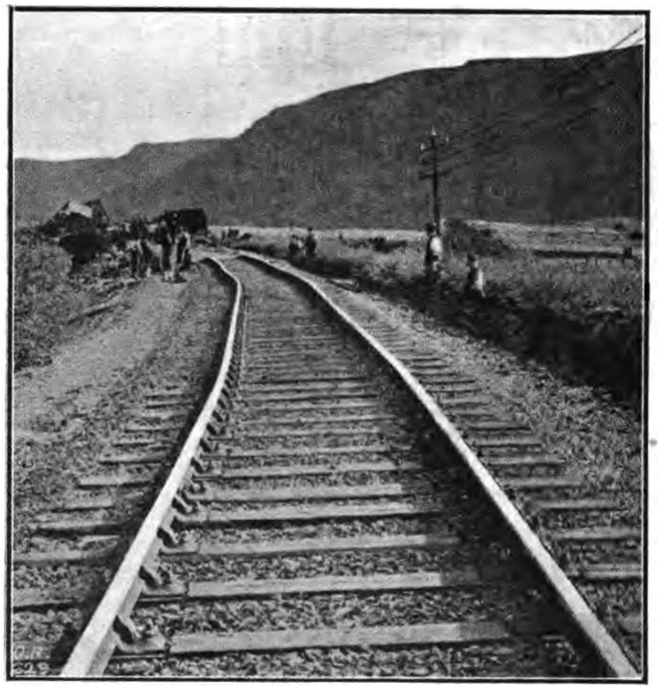


Fig. 1.

The line between Llandudno Junction and Bettws-y-Coed is single and follows the valley of the river Conway. At the site of the accident the road bed is carried on a low embankment, which is floated on the bog, or moss. It is practically level, and on a curve to the left, varying from 32 to 37 chains radius (see fig. 2).

The permanent way consists of bull-headed steel rails, laid in 1878, when they weighed 75 lbs. per yd., their present weight being about 71½ lbs. The rails are of superior quality; some of them were badly twisted, but none of them were broken. New sleepers were laid in 1902, 11 sleepers to a 30-ft. rail. The chairs, which weigh 45 lbs., are secured

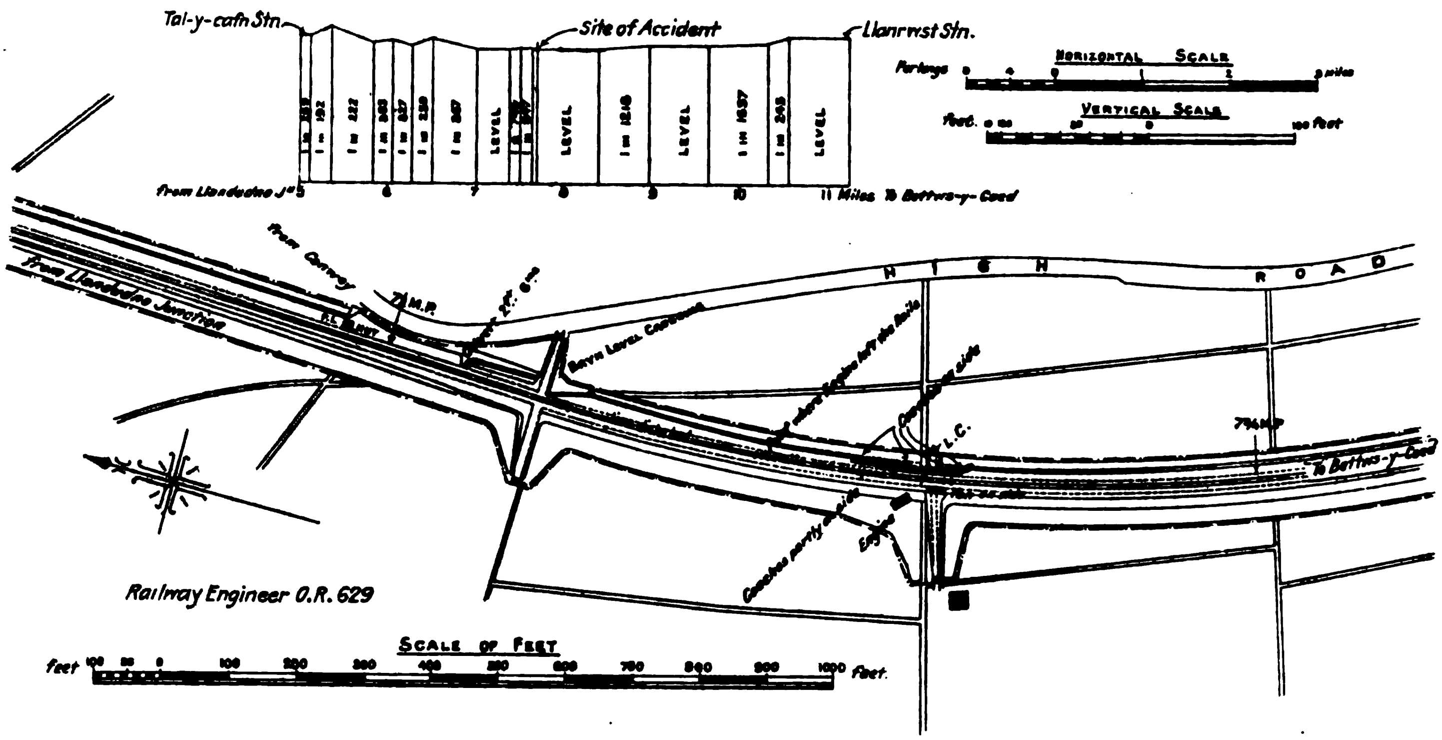


Fig. 2.

to the sleepers by two coach screws and two spikes each. The sleepers were supplied from Garston where the chairs are attached to them by machinery, so that the gauge was correct. The gauge on the curve was the same as on the straight. The road is well ballasted with broken granite, and was in first class order.

The ends of the curve are eased off by transition curves so as to render the curvature as gradual as possible.

The engine is an 8-wheeled 4-coupled side tank engine with radial axles at either end. It was built in 1883, and was last in shop for general repairs in January, 1903, when the tyres were turned up, and left $2\frac{7}{16}$" thick.

The wheel base of the coupled wheels is 7 ft. 9 ins. and the centres of the leading radial axles are each 6 ft. 9 ins. from the centre of the nearest driving axle. The weights on the wheels are:—Leading (radial) 10 tons 1 cwt.; leading driving 13 tons 10 cwt.; rear driving 13 tons 6 cwt.; trailing (radial) 9 tons 1 cwt.; total 45 tons 18 cwt. The coupled wheels are 4 ft. $8\frac{1}{2}$ ins. diam., and the radial wheels 3 ft. 3 ins.

The cylinders are in front of the leading wheels, the overhang of the frame of the engine beyond the radial axles being at the leading end 5 ft., and at the trailing end 3 ft. 9 ins.

The radial axles have a lateral movement of $1\frac{3}{8}$ ins. on each side, and are normally held in a central position by means of helical springs. Axles of this description have been in use for many years on the L. and N. W. R.

After the accident the front portion of the engine was found to be firmly imbedded in the marshy ground on the right-hand side of the line. It had turned completely round so that its chimney was then facing towards Llandudno. It was not raised from that position until a fortnight later, when it took eight locomotives to haul it out of the hole which it had made for itself. The front carriage had also turned round, and fallen on its side on the roadway of the occupation level-crossing which exists at that spot.

It is generally difficult in cases of derailment to arrive at a definite opinion as to the cause of the accident, but there are circumstances attending this case which suggest a possible explanation of the occurrence.

The marshy ground, a somewhat light rail, an engine liable to oscillate, and high speed (60 m. an hour), in combination, are sufficient to account for the derailment. A large number of engines of the same type have been in use for some years past upon the L. and N. W. R. without accident, but they cannot be regarded as express engines, and are not usually timed to run at a speed of 60 m. an hour. In view of the experience gained by the present accident, it would be advisable to limit the speed of engines of the type in question to 40 miles an hour as a maximum.

*

At Broad Street Station, N. L. R., *on the 18th August. Lt.-Col. P. G. von Donop, R.E., reports that:—*

The 9.46 a.m. up passenger train (engine and 13 vehicles) from Poplar to Broad Street, ran into the 10.15 a.m. down train (engine and 13 vehicles), which was standing on one of the bay platform lines.

Six servants and 56 passengers were injured. The damage to the rolling stock was considerable.

Both engines were of precisely similar construction, and all the vehicles were four-wheeled, fitted with the vacuum brake to all wheels.

There are two sets of main lines running into Broad Street Terminus. The Poplar train was running into the station on No. 1 up line, which is on the south side on No. 1 down line. The station has 8 bay platform lines, but the only ones connected with this accident are Nos. 1 and 2, which are on the south side of the station, and which run alongside each other between Nos. 1 and 2 bay platforms. These platforms are each 545 feet in length. Each of these platform lines is signalled both for arrival and departure, and the signals for trains departing from and arriving at them are just beyond the end of each platform.

At the time this collision occurred the Chalk Farm train was standing on No. 1 bay platform line with its engine 15 yards in rear of its starting signal, and it was due to start in about four minutes. The Poplar train was entering the station, and it was due to run into No. 2 bay platform line which was empty at the time.

There is a signal-box, known as No. 1 signal-box, situated just to the north of No. 1 up and down lines and 80 yards from the east end of the station platforms.

The next signal-box in the down direction is Skinner Street signal-box, which is on the south side of the main lines, and situated at a point about 200 yards to the east of No. 1 box.

There is on No. 1 up line a facing connection near No. 1 signal-box. The points of this connection lie normally for No. 1 platform line, but when pulled over they give access to

No. 2 platform line. It was through this connection that the Poplar train was due to run to reach No. 2 platform line. The splitting signals for this facing connection are close to the Skinner Street signal-box at a point distant 217 yards from the facing point. These splitting signals are worked from the Skinner Street box, but No. 1 signal-box has control over them by means of slots.

The circumstances under which this collision occurred are clearly shown by the evidence of signalman Prior, who admits that it was primarily due to a mistake on his own part.

The Poplar train had been duly offered to Prior, who was on duty in No. 1 signal-box, by the signalman in the Skinner Street signal-box. Prior had accepted the train and had set the road for it to run from the No. 1 up main line through the facing connection near No. 1 signal-box into No. 2 platform line; he had then lowered his station entering signal and had taken off his slot on the splitting signal near the Skinner Street box for it. No. 2 platform line was empty at the time, so Prior had done everything quite correctly, and the interlocking prevented his shifting the above-mentioned facing points until the station entering signal had been put back to danger.

Before, however, the Poplar train had reached the facing point Prior got the idea into his head that that train had already run into the station; he can give no explanation as to how he came to be under this impression; if he had looked out in the down direction he could have seen the train approaching, or if he had looked in the up direction he could have seen that the train was not in the station, but he seems to have been so certain on the point that he did not consider it necessary to verify it by looking out in either direction. He accordingly put back both the splitting signal and the station entering signal to danger, and reversed the facing points, putting them back to their normal condition in which they lie for No. 1 platform line. He had no sooner done this than he saw that the Poplar train was entering the points; he at once realized what he had done, but it was then too late to take any steps in the matter.

The driver and fireman of the Poplar train both state that they saw the signal for No. 2 bay platform at Skinner Street box was lowered for them, and that on rounding the curve they saw that the station entering signal for that platform line was also lowered. Having seen that this latter signal was at safety, both these men appear to have taken their eyes off this signal, and neither of them noticed that it was thrown to danger just before their engine reached the facing point. The driver first discovered that he was on the wrong road when he was a few coach lengths distant from the engine of the Chalk Farm train. Steam had been turned off some four or five hundred yards back; the driver at once applied his vacuum brake, but, though it worked well, his engine was then too close to that of the Chalk Farm train for his train to be stopped before the collision occurred.

Prior has the highest possible character; he has been 39 years in their service, and they have always regarded him as one of their best and most reliable signalmen; only two years ago he was specially awarded a gratuity in recognition of his promptness in averting an accident.

Attention is called to the hours of duty worked by Prior previous to this accident. His usual hours of duty were 8 per diem. Owing, however, to its being the time of year at which the men take their holidays Prior had for the week previous to this accident been working beyond his usual hours, viz., for 76 hours out of the 168, for the three days previous to the accident, he had been on duty for 37 hours out of 72, or slightly over 12 hours per diem. These hours were too long for the work of the heavy and responsible nature which Prior had to do, and they may undoubtedly be regarded as having led to his making such an unusual mistake. The company's serious attention should therefore be drawn to this point.

Driver Seymour and fireman Maund cannot be entirely absolved from blame in this matter by reason of their not having seen that the station entering signal had been thrown to danger. The interlocking rendered it necessary for that signal to be put to danger before the points were shifted, and, as the points are provided with a locking bar, they must have been shifted before the train reached them; the points are 112 yards from the signal, and the engine must therefore have been at least 130 yards from that signal when it was put to danger. Had these men been keeping a careful look-out they should when running through that distance have seen that the signal was against them. It must, however, be admitted in their favour that they had previously seen both signals off for them, and that it is most unusual for a train to be stopped after passing Skinner Street signal-box.

*

Near TONTEG JUNCTION, BARRY R., *on the 6th October. Lt.-Col. E. Druitt, R.E., reports that* :—

A train, consisting of an engine, 50 empty wagons and a van, collided with a train loaded with pitwood. W. Henshaw the driver jumped off his engine and was killed by the first wagon of his train falling over on him, and the fireman was shaken.

A train of wagons of pitwood was being formed at Tonteg Junction by joining up wagons dropped from previous trains, when Pugh the signalman at the signal-box was offered a train of empty wagons from Cwm signal-box (the next one then open behind Tonteg Junction on the up line), and which he accepted at 3.43 a.m. At that time the up siding was full, or nearly so, and the engine and about 15 wagons of pitwood were standing on the up branch line to Treforest, having been placed there to clear the up main line to Hafod for the previous train which left at 3.40 a.m.

After accepting the train of empties at 3.43 a.m., Pugh brought back the engine and wagons from the up branch line on to the up main line and they were joined up to the wagons in the up siding, and the train was ready to start and the up branch starting signal lowered at 3.50 a.m. But as the branch line is on a steep gradient, the train had to stop to pin down brakes soon after starting, and the rear of the pitwood train had not cleared the siding when the train of empty wagons arrived, and over-running the home signals which were at danger, collided with the pitwood train at 3.57 a.m.

Henshaw, the driver, was apparently under the impression that the home and distant signals for the main line were "off" for him, although he could not see them owing to the lamps being extinguished. Under these circumstances it was, of course, his duty to have regarded the signals as being at danger, and to have come to a stop at the home signals. There is no doubt that at the time only one of the two home signal lamps was burning, and this was showing a red light.

But Pugh, the signalman, is very seriously to blame for bringing back the engine and wagons from the up branch line on to the up main after accepting the train of empties at 3.43 a.m. He admits that he knew that by so doing he was infringing the rules for block working, and his excuse was that he thought there was time to get the pitwood train away on the branch before the arrival of the other train. The breach of block working at Tonteg Junction requires the serious attention of the Company as this was not an isolated case, and more care is apparently needed with the lamps of the signals.

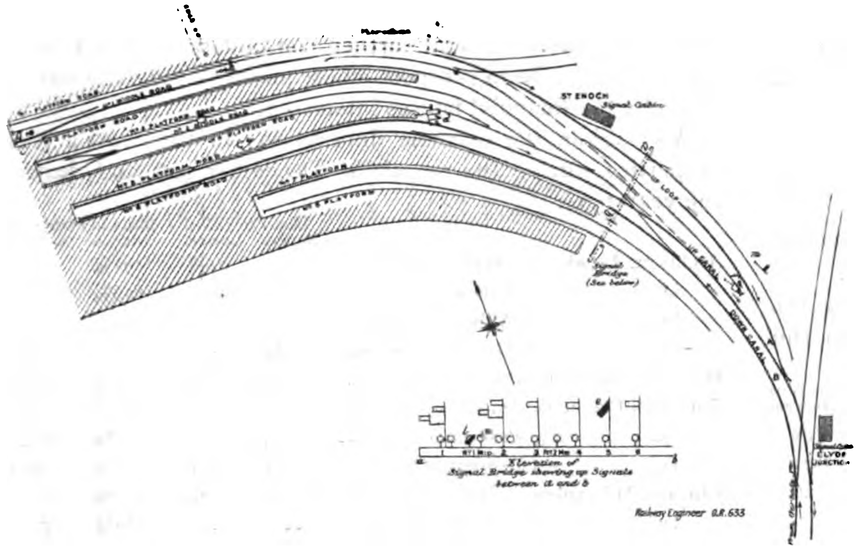
*

Outside ST. ENOCH STATION, GLASGOW, G. & S. W. R., *on the 17th September. Major J. W. Pringle, R.E., reports that* :—

A light engine ran into the 9 p.m. up passenger train, Glasgow to Kilmarnock. The light engine and 4 passenger vehicles were derailed and fouled the adjoining down line and were run into by the 8.25 down passenger train, Barrhead to Glasgow; 19 passengers and one of the firemen were injured.

The up train consisted of a 4-coupled engine, tender, and 10 vehicles, equipped throughout with the vacuum automatic brake, working on the coupled engine and six tender wheels, and 44 out of 62 coach wheels. The light engine was 4-coupled and was running tender first. The down train consisted of a tank engine, and 8 six-wheeled vehicles, fitted with the vacuum automatic brake. The brakes were in good working order.

The lines and signals concerned in this collision are shown on the accompanying sketch plan of the northern portion of St. Enoch Station, and the route traversed by the light engine is indicated by the heavy black line. The point of collision is marked B, and the signals concerned *g*, *h*, *k*, *l* (on the signal bridge), and *m*. The first four of these signals, which are electric shunt signals, were "cleared" for the light engine. The last, *m*, is the up loop home (semaphore) signal at Clyde Junction, which stood at danger. The signals which governed the 9 p.m. up passenger train are marked *c*, *d*, *e* (on the signal bridge), and *f*, all of which are of the semaphore type, and were cleared for the train. The last signal, *f*, is the up Canal home signal at Clyde Junction, and was the signal taken by the driver of the light engine as referring to himself.



The chain dotted line shows the route which the driver of the light engine thought he was taking. The shunt signal *n*, the fourth disc signal from the left, on the bridge governs this route.

It will be noticed that the direction of the railway lines changes from east and west alongside the station platforms, to north and south at Clyde Junction.

The signalling arrangements in the station yard, and at Clyde Junction, have been quite recently installed, and are of the most modern description.

Each group of signals on the bridge, *a*, *b*, spanning the lines at the east end of the station, is as far as possible immediately over the line to which it refers, and, as shown on the elevation of the signal bridge, given on the sketch, to each group is attached a numeral corresponding to the platform line or road from which a train has started.

With the object of rendering the signalling clearer, more than one signal has been sometimes provided for a single movement. Thus the first, third and fifth disc signals on the bridge, counting from the left (*vide* sketch), refer to one and the same outward shunting movement on the up loop line, according as the vehicle is moved from No. 1 platform, No. 1 middle, or No. 2 platform road respectively. Similarly the first and third semaphore signals refer to a running movement on the same line, either from No. 1 or 2 platform roads. There are therefore five separate signals for an outward movement on the up loop line between St. Enoch signal cabin and the spot marked *m*.

The following are the approximate distances from the buffer stops at the west end of No. 1 platform road to the undermentioned places measured along the up loop line:—Shunt signals at Dunlop Street 166 yds.; starting signals near water column 300 yds.; St. Enoch signal cabin 400 yds.; signal bridge *a*, *b*, 438 yds.; up loop line home signal at Clyde Junction 555 yds.; spot where collision occurred, marked A on sketch, 600 yds.

It is proved that the 9 p.m. passengers train to Kilmarnock had been duly offered to, and accepted by, the signalmen in Clyde Junction and Gorbals Junction signal cabins. Further, that all the proper signals controlling the passage of this train, from No. 5 platform road in St. Enoch Station, on to the up Canal line past Clyde Junction, had been drawn "off," and that the Canal line home signal at Clyde Junction indicated "safety," when the collision took place.

On the other hand, the light engine had been offered to, and refused by, the signalman in Clyde Junction signal cabin. Although, therefore, all the necessary shunt signals to authorise the light engine to draw out of No. 1 middle road on to the up loop line were standing at "clear," the up loop home signal at Clyde Junction was at "danger" when the engine passed it.

The immediate cause of the collision was the unauthorised movement of the light engine past this home signal at danger. The driver, Glover, states that he was not aware that he was travelling on the up loop line. On all other similar occasions, after leaving No. 1 middle road and No. 1 platform road, he had travelled over the up Canal line through the crossing shown in the sketch by chained dotted lines. On this occasion he thought he was moving by this same route, and therefore accepted the clearance of the up Canal line home signal as referring to his light engine. He had never previously travelled out of St. Enoch Station yard by the up loop line, and was not aware that any of the shunt signals on the signal bridge were applicable to a movement on this loop line. He stated that he had formed this opinion from the printed signalling instructions for St. Enoch Station, because they contained no mention of shunting signals for such a movement. The lines and crossings, especially in this north-east corner of the station, are numerous and complicated. To a driver not intimately acquainted with the working arrangements they must present difficulties. At the same time to such a man the need of special caution and alertness must be obvious. Had Glover been travelling on the up Canal line he would have passed over three ordinary crossings as well as one diamond crossing west of St. Enoch signal cabin, whereas on the up loop line there are no points or crossings between St. Enoch signal cabin and the site of the collision. Moreover, after passing the signal cabin, the home signal he accepted as applicable to himself would have appeared on his left hand, if he had approached it by the up Canal line, whereas it showed on his right hand as he approached it on the loop line. Taking these facts into consideration, had he been alert and cautious he could not have failed to recognize that he was on a different road to that which he thought he was on.

The evidence of the engineman, and of signalman Kerr, proves that the signals, especially in the northern part of St. Enoch Station, are difficult to read at sight by men not thoroughly conversant with all the details of working in the station yard. It is also the fact that the signalling instruction merely state that the third and fourth shunt signals on the bridge, counting from the left, are leading signals for No. 1 middle road. The explanation is not given that the fourth signal governs a movement on to the up canal line, and the third a movement on to the up loop line. In this respect the instructions are incomplete, and require amplification.

But admitting that the signals are difficult to read, and that the signalling instructions are not fully explanatory, it is not clear why Glover, on receiving the third shunt signal, should not have remembered that on other occasions he had received the fourth shunt signal, and consequently acted with greater caution than he did.

It is highly desirable, both from the point of view of safety and for traffic purposes, that signalling in a large terminus should be as complete as possible. At the same time there is a danger to be guarded against, namely, confusion owing to a multiplicity of signals. The evidence in this case points to the necessity for adopting some method of ensuring that enginemen, especially those who are only occasionally called upon to work in a large terminus, are thoroughly conversant with the working arrangements and signalling. It does not appear to be sufficient to issue printed signalling instructions.

Financial Notes and Statistics.

The market for Home Railway stocks has fluctuated in narrow limits, public interest being to some extent diverted in other directions. The dividend announcements so far published have been without special feature, but are distinctly satisfactory from an investment point of view. Those lines adopting electric power are attracting chief interest; the change appearing to be more and more popular amongst the travelling public. For the 26 weeks of the half-year to December 31 last, the gross receipts of the 41 English and Welsh, the 7 Irish, and the 5 Scotch companies were £51,894,000, a decrease of £314,000. Passenger traffic was £90,000 more, but goods takings were £404,000 smaller.

The extreme fluctuations officially recorded during the month of December last and during the year 1904 in the most prominent stocks are below.

	Dec. 1 to 31,'04. Highest	Lowest	Jan. 2 to Dec.31,'04 Highest	Lowest
Caledonian	111	108	111½	98
Do. Pref. Con. Ord. (3%)	78½	76¼	79⅝	71
Do. Defd. do.	34½	32¾	34½	26
Central London	92½	90½	97	86
City and South London Cons. Ord. ..	47	45½	52	40¼
East London Consolidated	5¾	5½	6½	4¼
Furness	57	55½	62½	48¼
Glasgow & South Western Pref. (2½%) Ord.	63½	63	67	62¼
Do. do. Deferred Ordinary	39	38	41⅝	33
Great Central Preferred (6%)	31½	30⅝	31⅞	21⅞
Do. Deferred	17 1/16	16¾	17 1/16	12⅝
Great Eastern	93¼	89⅞	95	82½
Great Northern Pref. Con. Ord. (4%) ..	103⅝	99½	104	96
Do. Def. Conv. Ord... ..	41½	39⅝	43 1/16	34 1/16
Do. "A"	37¾	36¾	40	31⅛
Do. "B"	152½	151	157	146½
Great North of Scotland Pref. (3 %) Ord.	73	73	73½	70¼
Do. do. Deferred Ord. ..	29¾	29¾	30¾	26⅝
Great Western	142	139⅛	144⅞	130
Highland	52	50¼	52	40
Hull, Barnsley, and West Riding Junctn.	42⅞	40¼	44⅞	33
Lancashire and Yorkshire	111¼	107⅝	111¼	87⅝
London, Brighton, and South Coast ..	139⅞	136	139⅞	123
Do. do. Preferred (6%) ..	155½	151¾	157	145
Do. do. Deferred	127¼	122½	127¼	103
London, Chatham, and Dover	17⅞	16 11/16	17⅞	12⅞
Do. do. 4½% 1st Preference	101½	99⅝	104	87
Do. do. 4½% 2nd Preference	68	65	70½	52
London and North Western	156½	151	159¼	142½
London and South Western	158½	152½	167	146
Do. Pref. Conv. Ord. (4%)	105⅞	104⅜	110½	100½
Do. Def. Conv. Ord. ..	54½	52⅞	58⅝	46
London, Tilbury, and Southend Con. ..	146	145	155	140
Metropolitan	100⅝	96⅛	102	83
Metropolitan District	41¾	39½	44¼	32
Do. do. 5% Preference ..	85⅝	84¾	85⅝	68
Midland Preferred (2½%)	68½	66½	71½	64½
Do. Deferred	66	63½	71½	59¼
North British Ord. Pref. (3%)	78	77	79⅝	74⅞
Do. Ordinary	48⅝	47¼	48½	38⅛
North Eastern Consols	140⅝	137½	145¼	131½
North London	142	132	159¾	132
North Staffordshire..	96½	95½	99	90¾
Rhymney	..	..	201½	180
South Eastern	92¾	91	98	82
Do. Preferred (6%)	133	128½	135¾	117¾
Do. Deferred	58¾	55½	64¼	47
Taff Vale	76½	74	78¼	68½

The easy condition of the New York money market is exercising a powerful influence over the market for American Railway shares. The commercial position in the United States continues highly encouraging and the chances of any disturbing legislation against railways are now considered remote. Several further consolidations of interests are believed to be in prospect, consequently strong support is given by the financial houses interested.

We subjoin the extreme fluctuations in the most active properties during the month of December last and during the year 1904.

	Dec. 1 to 31,'04. Highest	Lowest	Jan. 2 to Dec.31,'04 Highest	Lowest
Atchison, Topeka, & Santa Fé Common	91 3/16	84¼	91¾	66
Do. 5 % Preference ..	106½	104½	106⅝	90⅝
Do. 4 % Adjustment Bonds	97½	96¼	100	90½
Do. 4 % General Mortgage	106¾	105	107	100½
Baltimore and Ohio Common . ..	107¼	99 15/16	107¼	75½
Canadian Pacific Common	138¼	131¾	139¼	112½
Do. 4 % Preference	103¼	102¼	103⅝	100¼
Do. 4 % Debenture Stock ..	111¼	108½	111⅞	105¼
Chicago, Milwaukee, & St. Paul Common	181¾	170¾	181¾	141½
Do. do. 7 % Preferred	..	..	181¼	177
Denver and Rio Grande Common ..	34⅞	30⅞	35⅞	18⅞
Do. do. 5 % Preferred ..	91¾	86¾	91¾	67
Do. do. 4 % 1st Mort. Bds.	105¼	102	105¼	99¾
Erie Railroad Common	41⅝	35 15/16	42⅞	22½
Do. 4 % 1st Preferred ..	78¼	74 1/16	78¼	57⅝
Do. 4 % 2nd Preferred ..	..	..	55⅝	35⅝
Do. 4 % General Lien ..	94	91½	94	85½
Grand Trunk of Canada Ordinary ..	22 3/16	19¾	22 3/16	11⅛
Do. do. 3rd 4 % Pref. Stock	50¼	47¼	50¼	34⅝
Do. do. 2nd 5 % do.	97⅞	94½	97¼	80⅝
Do. do. 1st 5 % do.	109	106⅝	111¾	97¼
Do. do. 4 % Guaranteed	99½	97¾	101	95½
Do. do. 4 % Deb. Stock	107⅞	106⅝	107⅞	103
Illinois Central Common	162¼	145	162¼	129¾
Do. 4 % Gold Bonds, 1953 ..	107¾	106¼	108½	104½
Louisville and Nashville Common ..	151⅝	139⅞	151⅝	103½
Do. 4 % Unified Bonds, 1940	106½	103½	106½	100¼
Mexican Railway Ordinary Stock ..	27⅝	25⅛	29⅞	14½
Do. 8 % 1st Preference Stock	108⅛	106⅝	111	61¼
Do. 6 % 2nd Preference Stock	50 1/16	46⅛	53½	22
Missouri, Kansas, and Texas	35½	29⅞	37⅛	15¼
Do. do. 4 % Preferred ..	66⅝	63⅝	66⅞	38¾
Do. 4 % 1st Mt. Bds., 1990	103¾	103½	106	99
New York Central Common	149⅝	137½	149⅝	116⅝
Do. 4 % Debenture, 1905..	102	102	104	100½
New York, Ontario, & Western Common	45 11/16	42¼	48 11/16	20
Do. 4 % Mort. Bonds, 1992	..	..	107½	101
N. Y., Penns., and Ohio 4% 1st Mt. Deb.	93	92½	94	89
Norfolk and Western Common	82½	77	82½	55¾
Do. 4 % Preference ..	94½	94	95	87
Do. 4 % 1st Cons. Bds.	104	104	104⅝	96
Pennsylvania ($50 shares)	71¾	68⅝	71¾	57
Reading Co. ($50 shares) . ..	42 3/16	38⅝	42 3/16	20 3/16
Do. 1st 4 % Preference.. ..	47 3/16	45	47 3/16	38
Do. 2nd 4 % Preference.. ..	42¾	40¾	42¾	28
Southern Pacific Common	69½	61¼	70½	43 1/16
Southern Railway Common	38½	33 13/16	38½	18⅞
Do. 5 % Preferred	99½	98¼	99½	81
Union Pacific Common	119½	109	119 13/16	74
Do. 4 % Preference	99½	97	99½	88
Do. 4 % 1st Mort. Bonds 1947	110	107	110	103¾
Wabash Common	24¼	20½	24¼	17¾
Do. Preferred (7 %)	48¼	42⅞	49½	33¾
Do. 6 % "B" Deb. Bds.	70½	68	71½	57½

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THE
Railway Engineer

VOLUME XXVI., No. 302. *MARCH,* 1905.

Contents for March.

Viscount Ridley, of Blagdon Hall, Northumberland, has been elected a director of the North Eastern R., the vacancy having been caused by the death of Sir I. Lothian Bell. He is a son of the late chairman of the company.

Mr. C. T. Yerkes, Chairman of the Underground Electric Railways Co. of London, Ltd., has been elected Chairman of the Metropolitan District R. in succession to **Mr. R. W. Perks, M.P.,** who has retired into the deputy chair, in place of **Mr. L. H. Isaacs,** who has resigned his directorship.

Mr. L. S. Smart, manager of the locomotive works, L., Brighton and South Coast R., has been appointed locomotive superintendent of the Central South African Rs. in succession to Mr. P. A. Hyde, who has resigned.

Mr. W. J. Hosgood, engineer and locomotive superintendent of the Port Talbot R. and Docks, has been appointed locomotive superintendent of the Rhodesian Rs.

Mr. S. Hauxwell, assistant goods manager of the Lancashire and Yorkshire R., has been appointed assistant passenger superintendent and goods trains superintendent in succession to the late **Mr. Geo. Banks,** and **Mr. W. A. Marsden,** district goods superintendent at Bury, to succeed Mr. Hauxwell.

Mr. H. N. Gresley, assistant carriage and wagon superintendent of the Lancashire and Yorkshire R., Newton Heath, has been appointed to a similar position on the Great Northern R. at Doncaster, in succession to **Mr. E. F. Howlden,** who has retired, and he has been succeeded at Newton Heath by **Mr. J. P. Crouch,** assistant of the running department.

Mr. R. Mansell, sssistant locomotive carriage wagon superintendent of the Great Southern and Western R. of Ireland, has been appointed assistant locomotive superintendent of the Great Northern R., in succession to **Mr. D. E. Marsh.**

Mr. C. Lundie has, owing to his advanced age (being over 90), resigned the position of general manager, engineer and locomotive superintendent of the Rhymney R., and which he had held for the past 43 years. He has been elected a director of the company.

*

Estates left by Railway Men.

The late Sir I. Lothian Bell, the great iron master and a director of the North Eastern R.—£768,676 gross and £674.317 net.

The late Viscount Ridley, Chairman of the North Eastern R. —£535,616 gross and £281,975 net.

The late Mr. R. J. Billinton, for 15 years locomotive, carriage and wagon superintendent of the L. Brighton and South Coast R., about £45,000 net.

*

New Regulations for Heavy Motor Cars.

THE "Heavy Motor Car Order, 1904," and the new regulations drawn up by the Local Government Board came into operation on the 1st ultimo. They are of considerable interest to railway companies, for without doubt the heavy motor car will in the near future displace the horse-drawn van for the collection and delivery of goods.

Under these regulations all motor cars of a greater tare weight than two tons is deemed to be "heavy," and the maximum tare weight permitted has been raised from three to five tons. This will remove the great obstacle, which has hitherto proved unsurmountable, to the construction of a really satisfactory heavy steam motor car. The joint tare weight permitted for a motor car and its trailer has been raised from four and a half to six tons and the gross weight to 12 tons and the axle load to eight tons.

The width of the tyres must be proportionate to the load carried and to the diameter of the wheel, but no plain, *i.e.*, non-pneumatic or rubber, tyre must be less than 5 ins. wide; for example, a load of three tons on a wheel 3 ft. in diameter requires a tyre 8 ins. wide and on a wheel 5 ft. diameter a tyre 6½ ins. wide. No wheel may be less than 2 ft. in diameter, and all vehicles must be spring hung.

Cars of three tons tare and upwards may be 7 ft. 6 ins. wide, and the speed of such cars is limited to five miles an hour. but with a tare of less than three tons the speed may be eight miles an hour.

The axle load of a trailer is limited to four tons, and if the tare of a trailer exceeds one ton the rules as to the width of tyres for motor cars are to apply, but a minimum width of 3 ins. will be permitted. Trailers must not be used on stage carriages.

Fines not exceeding £10 may be inflicted for the breach of any of these regulations.

Fire and Water Proof Dynamos.

A STRIKING instance of the durability of modern well-made electrical machinery comes from the United States.

The New England Building at Cleveland, Ohio, is electrically lit throughout by a plant consisting of three Westinghouse 62.5 K.W. engine type generators, installed in the basement; which, through some carelessness, recently became the scene of a rather serious fire. The heat to which the machines were subjected was sufficient to completely burn away the insulation on the outside of the field coils; and for an hour they were played upon by six hose pipes. Within an hour of the extinction of the fire the first of these machines was carrying its full load, and another followed suit in a short time, the two dealing with the entire lighting of the building that under normal conditions was negotiated with three machines.

With the exception of the outer layer on the field coils, which was burnt away, the insulation was fireproof, and easily withstood a heat that was sufficient to burn and blister the paint on the frames. The two elements most fatal to electrical machinery were thus resisted in a most unexpected manner, and in a way that proved the sound and good manufacture of the dynamos.

*

Electric Traction on the L. Brighton and South Coast Railway.

IN connection with the above it is interesting to record that the L. Brighton and S.C.R. Co., acting on the advice of their con sulting electrical engineer, Mr. Philip Dawson, have decided to instal electric traction upon a length of about five miles of their suburban line between Battersea and Peckham Rye upon the overhead system, with a single high-tension overhead conductor for each line and single-phase motors. This system, which is in successful operation both in America and on the Continent, does away with the dangerous "live-rail;" if it should be successful financially its use will be extended.

*

Electrification of Suburban Lines.

WE note with regret that neither the Chairman of the North Eastern R. nor the Chairman of the Lancashire and Yorkshire R. were able at the recent half-yearly meetings to tell the shareholders anything as to the financial results of the working of the electrified sections of their railways. Both announced large increases in the numbers of passengers carried, but as to whether there was any profit in this traffic no information was forthcoming, and as chairmen are not given to concealing success one would be almost justified in assuming that at any rate there is no profit from these sections yet.

Everyone knows that Mr. Aspinall does not expect to save money but to make money, in which case he will be cleverer than his American brother managers if we are to believe our contemporary *The Railway Age*, which, in answering its own question, remarks:—

Are inter-urban electric railways profitable? It is getting to be time to have figures which will throw some light on this exceedingly interesting question. While the construction and operation of long-distance electric roads may be said, in general, to be still in the experimental stage, there are many such roads of from, say, 10 to 50 and more miles in length which have been running for several years, and should give some idea of the relation of earnings to capitalisation and operating expenses. So far, however, there are few if any examples of purely inter-urban roads which are paying dividends, and the number which have been unable to earn interest on their bonds is not small. As a general proposition, to which there are exceptions, the operations of rural lines have been disappointing, both as to earnings, which have not come up to the predictions, and as to expenses, which have increased beyond all expectation. The latter condition is largely due to the expenditures found necessary in the way of track, rolling stock, station service, freight houses, sidings, telegraph and telephone equipment, &c., as a result of undertaking to compete for freight and passengers with the steam roads.

*

Euston-Birmingham Express Service.

THE London and North-Western R. Co. evidently do not intend to have their valuable Birmingham traffic encroached upon by others without an effort. Until this month there was only one train that made the journey in two hours, viz., the 5 p.m. ex-New Street non-stop to Euston, and a very crowded train it always is. Now at one stroke the company have no less than eight two-hour trains, leaving New Street at 8.40 a.m., 11.25 a.m., 2.45 p.m. and 5 p.m., and Euston at 11.50 a.m., 2.30 p.m., 4.45 p.m. and 6.55 p.m. Some of these trains are accelerated existing trains, but four of them are new ones, and give the additional service that has been wanted, since Birmingham suffered somewhat when the Manchester and Liverpool trains were accelerated.

The company have improved their through service from Birmingham, Manchester and Liverpool to the South Coast towns *via* the Brighton Co.'s line. They have also improved the service from Birmingham to Stoke and have put on an additional train to London at 8.15 p.m.

And a fast direct service between Oxford and Cambridge is another feature of the North-Western time-table for this month.

*

Railway Pictorial Post Cards.

THE new sets of Pictorial Post Cards issued by the L. and North-Western R. Co., and numbered from 15 to 28 inclusive, are now ready. Many of these are of exceptional interest, and the whole 28 sets show practically every phase of railway working, past and present.

It is satisfactory to note that the designing and printing are done in England by a new carbontype process, which gives the very best results. The cards can be obtained at the stations, in the trains, and from all the company's agents, price 2d. per set of six cards, or post free from Mr. F. H. Dent, Broad Street Station, London. E.C. The cards are also sold singly.

Series Nos. 1 to 14 are as popular as ever, and over 1,400,000 cards have been sold during the five months they have been on sale. Collectors and others interested in railways will no doubt quickly obtain the complete series.

*

St. Louis Exhibition Award to the L. and North Western Railway.

THE Special Jury at the St. Louis Exhibition conferred the highest possible distinction, that of the "Grand Prize," upon the L. and North Western R. Co. for their exhibit, the previous award of "Gold Medal" having been adjudged insufficient and withdrawn.

No other European railway has gained such honours, the nearest approach being silver and bronze medals.

*

Railway Lantern Slides for Illustrating Railways.

LANTERN slides showing places of interest on the L. and North Western line are available for the purpose of illustrating lectures, &c. These are classified in the same order as the company's pictorial post cards, which will enable applicants to ascertain beforehand the general character of each slide, and there are in addition others, starting from No. 184, arranged under various heads, such as views in North Wales, locomotives, &c. Boxes for packing the slides are in three sizes to contain 12, 25, and 50 slides, the latter figure being about the maximum number lent for one reading. They are sent carriage paid to any lecturer in the United Kingdom, on the understanding that they will be returned at the earliest possible moment.

*

Fast Run on the Baltimore and Ohio Railroad.

ON Sunday, October 23rd, the president's special on the Baltimore and Ohio, composed of three private cars, a dining and a baggage car, drawn by an Atlantic type engine, No. 1,461, made a run of 131 miles between South Chicago and Garrett, Ind., in 132 minutes, including time lost in making three full stops and several slow-downs. Between Avilla and Garrett, Ind., 5 miles, the special attained a speed exceeding 90 miles an hour, and the run between Wellsboro and Ripley, Ind., 74 miles, was made in 61 minutes.—*The Railway Age.*

*

Proposed Light Railways.

THE Board of Trade have recently confirmed Orders authorising the construction of the *Hope, Bradwell and Castleton Light Railway* in Derbyshire, from near Hope Station, M.R., to Bradwell and Castleton.

*

Motor Car Speed Record.

IT is stated that at Ormond, Florida, on January 28th, in the 10 miles race, Edward Thomas, driving a 100 h.p. Mercédès motor car, beat the world's record of 6 mins. 50 secs. by covering the distance in 6 mins. 31·8 secs.

Compound 8-Coupled Goods Engine with Leading Radial Axle; L. and North Western Railway.

BY the courtesy of Mr. George Whale, M.Inst.C.E., chief mechanical engineer of the L. and North Western R., we are able to publish the annexed illustration, which shows one of Webb's 4-cylinder compound 8-coupled goods engines, which has recently been converted to the "consolidation" type by the addition of a leading radial axle.

The principal dimensions of the engine as altered are as under:

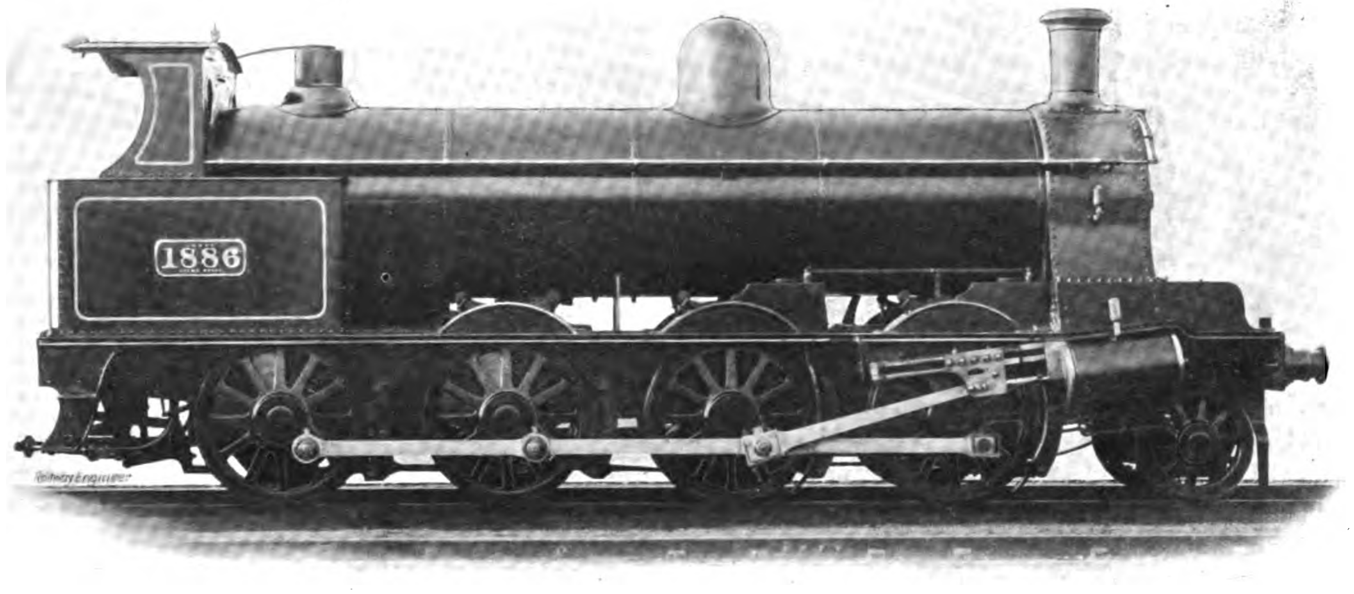
Cylinders, two h.p.	15 ins. diam. × 24 ins. stroke
„ two l.p.	20½ ins. diam. × 24 ins. stroke
Wheels, coupled	...4 ft. 5½ ins. diam.
„ leading...	... 3 ft. diam.
Wheel-base, leading axle to leading coupled axle	...6 ft. 4 ins.
„ „ leading coupled axle to driving axle	...5 ft. 9 ins.
„ „ driving axle to intermediate axle ...	...5 ft. 9 ins.
„ „ intermediate axle to trailing axle...	...5 ft. 9 ins.
„ „ total	23 ft. 7 ins.

Weight in working order distributed as follows:—

On the leading wheels	9	tons	19 cwt.
„ leading coupled wheels ...	7	„	10 „
„ driving wheels	13	„	1 „
„ intermediate wheels	13	„	1 „
„ trailing wheels	12	„	19 „
Total on coupled wheels ...	46	„	11 „
Total	56	„	10 „

Upon reference to the illustrated description which we published in our issue of September, 1902, of these engines as they were built it will be seen that the distribution of weight on the four axles was:—

On the leading axle	13	tons	16 cwt.
„ driving axle	17	„	4 „
„ intermediate axle	13	„	0 „
„ trailing axle	9	„	10 „
Total	53	„	10 „



Compound 8-coupled Goods Engine with Leading Radial Axle; L. & N.W. Railway.

It is, therefore, clear that though Mr. Whale puts rather less weight on the coupled wheels he gets a much better distribution of weight which will make the engine much easier on the permanent way and improve its running generally. These engines are admitted to form the most successful class of compounds that Mr. Webb built, but they will be more so as altered to "consolidations" in the same way that the large 4-coupled express compounds have been vastly improved by the addition of Mr. Whale's "duplex" valve gear, and thus rendered able to take the heaviest expresses without assistance at any time.

Books, Papers, and Pamphlets.

Electric Motors. By HENRY M. HOBART. London: Whittaker and Co., 2, White Hart Street, E.C. New York: 66, Fifth Avenue.

This is an excellent treatise upon the theory and construction of continuous current and induction motors, and one which should be very useful to railway men at the present time. It to some extent traverses the field already covered by other well-known works, but in the main it does not, and may be regarded as a valuable supplement to them. It is also as complete and up-to-date as any book dealing with a rapidly advancing science like electricity possibly can be.

The book is divided into two fairly equal parts treating respectively of continuous current motors and alternating current motors. The chapters following a short introduction deal respectively with continuous current motors, data for motor designing, types of winding, characteristics, designing and testing, standardisation, examples by various manufacturers, form wound armature coils, comparative designs for 35 h.p. motors, desirability of using polyphon motors, starting induction motors, comparisons between induction and continuous motors, design of induction motors, examples of induction motors, commutators in alternating current machinery, properties of copper wire of different gauges systematically arranged.

A striking feature of this book is the excellence of its illustrations, which number 480, and are in every way highly creditable to the publishers. We lay stress upon this matter because the value of books of this character is so often seriously deteriorated by inferior illustrations.

We can without hesitation strongly recommend Mr. Hobart's book to our readers as being in every way worthy of its place in Messrs. Whittaker's specialists' series of text-books.

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The Inventors' Guide to the Patent Law and the New Practice. By JAMES ROBERTS, M.A., LL.B., Barrister-at-Law. London: John Murray, Albemarle Street, W. 1905.

Seeing that the new practice, which was authorised by the Act of 1902, of making an official search prior to the granting of patents, came into operation at the beginning of the year the appearance of this book is particularly welcome just now.

It is founded on the same author's larger work on the grant and validity of British patents for inventions, but it is, nevertheless, complete in itself, and is intended for those "who require a simple "explanation of the law and rules governing the grant of patents in "the United Kingdom, and information as to the proper manner of "protecting their inventions so as to avoid the risk and consequences of premature disclosure of their ideas." The book is very concise and clear and free from legal phraseology, but it teems with references to standard works, so that those who wish to do so may look up the authorities for every statement made by the author. Few engineers are unwise enough to take out patents without the assistance of a competent patent agent, but those who contemplate doing so we strongly advise to first carefully peruse this book.

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Books Received.

The Elements of Railway Economics. BY W. M. ACWORTH, M.A. Oxon., Barrister-at-Law. Oxford: at the Clarendon Press. 1905. [159 pp.: price 2*s. net.*]

British Standard Specification for Pipe Flanges. Report issued by the Engineering Standards Committee, Leslie S. Robertson, M.Inst.C.E., secretary. London: Crosby, Lockwood and Son, 7, Stationers' Hall Court, E.C. December, 1904. [Price 2*s.* 6*d. net.*]

The Inventors' Guide to Patent Law and the New Practice. BY JAMES ROBERTS, M.A., LL.B., Barrister-at-Law. London: John Murray, Albemarle Street, W. 1905. [109 pp.; price 2*s.* 6*d. net.*]

Petroleum. BY SYDNEY H. NORTH. London and Newcastle-on-Tyne: The Walter Scott Publishing Co. 1904. [Price 1*s. net.*]

Gas Producers for Power Purposes. BY W. A. TOOKEY. A handbook for the use of purchasers, erectors and attendants. London: Percival Marshall and Co., 26-29, Poppin's Court, Fleet Street, E.C. [Price 1*s. net.*]

Petrol Motors Simply Explained. A practical handbook on the construction and working of petrol motors. BY T. H. HAWLEY. Illustrated. London: Percival Marshall and Co., 26-29, Poppin's Court, E.C. [Price 1*s. net.*]

The Beginner's Guide to the Lathe. An elementary instruction book on turning in wood and metal. BY PERCIVAL MARSHALL, A.I.Mech.E. Fully illustrated. London: Percival Marshall and Co., 26-29, Poppin's Court, Fleet Street, E.C. [76 pp.; price 6*d. net.*]

The Imperial Directory and Statistics of Electric Lighting, Power and Traction Works, 1905. Edited and compiled by C. S. VESEY BROWN, M.Inst. C.E., M.I.E.E. London: Hazell, Watson and Viney, Ltd., 52, Long Acre. [1,030 pp.; price 12*s.* 6*d. net.*]

The field covered by this directory has been greatly extended, and it now gives particulars of the electric lighting, power and traction works throughout the British Empire. The undertakings are arranged in four groups, viz.: Lighting and power, tramways, light railways, standard gauge and tube railways. Particulars are given as to the powers under which the undertakings are authorised, the names of the directors and officers, details of the machinery, cables and meters, and of trading accounts, balance-sheets, etc. The book is a very useful one.

The Colliery Manager's Pocket Book, Almanac and Diary for 1905.—Edited by R. A. S. Redmayne, M.Sc. London: Colliery Guardian Co., Ltd., 30 and 31, Furnival Street, Holborn, E.C. [287 pp.; price, cloth, 2*s.*]

The fact that this pocket book has reached its 36th year of publication is sufficient evidence of its value. It is especially prepared for the use of colliery managers and others engaged in mining operations, and in addition to ample diary space contains a great quantity of calculations, tables, formulæ and information of daily use in mining work, besides articles by experts on some of the principal mining subjects of the present time. The statistics will be very valuable to others besides colliery managers, as they are arranged very conveniently for referring to.

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Papers and Pamphlets Received.

Progress Report on the Strength of Structural Timber. BY W. KENDRICK HATT, PH.D., Civil Engineer in the Bureau of Forestry, United States Department of Agriculture. [22 pp. and VII. tables.]

This is a most valuable paper, which has been issued by the Bureau of Forestry of the Agricultural Department of the United States Government in response to many requests from timber dealers and users. It contains the results of cross bending tests on about 250 large beams of structural timber, but as these tests are still being carried on the results given may, of course, be modified in later publications, though they are sufficiently numerous to indicate the structural values of several species of timber, particularly loblolly pine and western hemlock. The species under investigation are the Oregon pine or Douglas spruce, the western hemlock, the red gum, the longleaf pine, and the loblolly pine. Later on the redwood (*Sequoia semper virens*) and the western yellow pine will be tested.

The present paper will be followed by a fuller report, which will contain authoritative and complete information concerning the mechanical properties of the commercial timbers of the United States, including the results of tests to determine—1, the mechanical and physical properties of timber in forms found on the market; 2, effect of rate of application of load, including impact tests; 3, effect of moisture; 4, preservatives; 5, methods of seasoning; 6, fire retardents.

The Greatest Economic Improvement in Railways. BY H. W. PERRY, Executive Engineer, Construction Branch, South Indian Railway, Trichinopoly. [59 pages.]

This advocates the use of wagons with detachable bodies on rollers so that the wheels and underframe may go away and be used for transporting other bodies while the first box is unpacked at leisure. Stress is laid upon the loss caused by the idleness of wagons. The Skeleton Car and Roller Box is apparently something like the wagons patented by Mr. Livesey and used for transhipping fish wagon bodies from the narrow to the broad gauge underframes in Ireland at Strabane, where the Donegal R. meets the Great Northern R. of Ireland.

The Renewable Rail and *The Continuous Rail.* BY H. W. PERRY (as above). Illustrated. [13 pp. and 28 pp.]

This pamphlet consists of two papers advocating respectively the use of a rail with a renewable cap on the running head and the use of a jointless rail. The suggested renewable cap would be of a channel section with the inner sides, vertical and gripping the head of the rail the sides of which would be inclined slightly outwards. The weight of the engine would press the former on to the latter with such force that it would become practically a part of the head of the rail. The continuous rail is obtained by dividing the rail proper vertically, breaking the joints and riveting them together and covering the head with the renewable cap mentioned above. The advantages and economies which would result from the adoption of this rail are set out concisely and clearly.

The Sleeperless Rail. BY H. W. PERRY (as above). Illustrated. [32 pp.]

In this pamphlet the author proposes the abolition of sleepers and the sbustitution therefore of girder rails, preferably of the sections discussed in the previously mentioned papers, with extended bottom flanges (14 ins. wide) resting on a 6 ins. bed of concrete, resting on 12 ins. of "rammed stone with the interstices filled with sand," and a cushion of sand ¾ or 1 in. thick immediately under the rails. The tie bars to be 5ft. apart, and the ballast on the outsides to be laid up to the undersides of the heads. He further suggests that a similar track might with advantage be laid on Indian highways, leaving the users, on payment of a toll, to find their own carts. The costs of such permanent way are compared with those of that now in use in India much to the disadvantage of the latter. These papers are interesting.

The History of the Ibstock Colliery (Private) Railway. BY CLEMENT E. STRETTON, C.E., Saxe Coburg House, Leicester. A short descriptive paper read at the Ibstock meeting of the Permanent-Way Institution.

Manufacturers' Pamphlets and Catalogues Received.

From the Brush Electrical Engineering Co., Ltd., Loughborough. *Canopies for Tramcars* and *Tramcar Design and Construction.* Both are useful and well-printed brochures intended to give information to municipal tramway committees and directors of tramway and light railway companies. The illustrations in the first named are particularly clear and well executed.

From Ed. Bennis & Co., Ltd., Bolton. A well illustrated description of the *Bennis Stoker and Compressed Air Furnace.*

From Joseph Kaye and Sons, Ltd., Lock Works, Leeds. An illustrated descriptive catalogue of their *Latest Improvements in Oil Cans.*

From the British Westinghouse Electric and Manufacturing Co., Ltd., Manchester. A revised edition of their fully illustrated and descriptive catalogue of the *Westinghouse Type "S.B." Direct-Current Motors.*

From the Phillips Commulator Grinder Co., Ltd. A well got up description of their *Commulator Grinder* for trueing commulators in situ. This seems to be a useful appliance, and the manner of its application is clearly illustrated. The evils of turning commulators is dwelt upon, and a long list of governments, corporations, and other important users is given.

From the Edison-Swan United Electric Light Co., Ltd. An illustrated catalogue of *Electric Cooking and Heating Apparatus.*

From Archibald Smith and Stevens, Battersea, London. *Notes on Electric Lifts*, the first half of which treats the subject from an engineering point of view and gives a good deal more original information than is usually done in publications of this kind. The latter half is the firm's catalogue revised up-to-date.

From Graham, Morton and Co., Ltd., Leeds. An elegant little booklet for the pocket, full of small but beautifully executed illustrations of cranes, conveyors and transporters (including aerial ropeways) erected by this firm in various parts of the world.

From Chambers, Scott and Co., Motherwell, N.B. An illustrated circular describing their *Modern Electric Winches.*

From Erith's Engineering Co., London. An illustrated pamphlet explaining the principles and describing the application of *Erith's Underfed Stokers or Boilers and other Furnaces*, and from which we gather that some thousands of these stokers are in use, and all giving satisfaction. It is also stated that these stokers were installed at the Crewe works of the London and North Western R. in 1901, and that a fourth order has recently been received for them for a new battery of Lancashire boilers at the Crewe works.

From W. F. Stanley and Co., Ltd., London. Price list and samples of *Sun Copying Papers Apparatus and Printing for Architects and Engineers.* The samples of the work done both on paper and linen by the new jet line (permanent carbon) process is particularly good and quite equal to an Indian ink drawing. This process is to be recommended in preference to the ferro-gallic or other so-called black lines on white. But unfortunately it appears to be more than twice the price of the old ferro-prussiate (white on blue) process, and about 25 per cent. more expensive than the ferro-gallic process.

From the Baldwin Locomotive Works, Philadelphia, Pa., U.S.A. *Record of Recent Construction No. 49. Balanced Compound Locomotives.* This booklet contains much useful information, and we shall take another opportunity of referring to its contents at greater length. It is, like its 48 predecessors, beautifully printed and illustrated.*

Incandescent Mantles for Railway Carriage Lighting.

THOUGH it is an established fact that lighting by means of incandescent mantles is one of the most economical systems known,

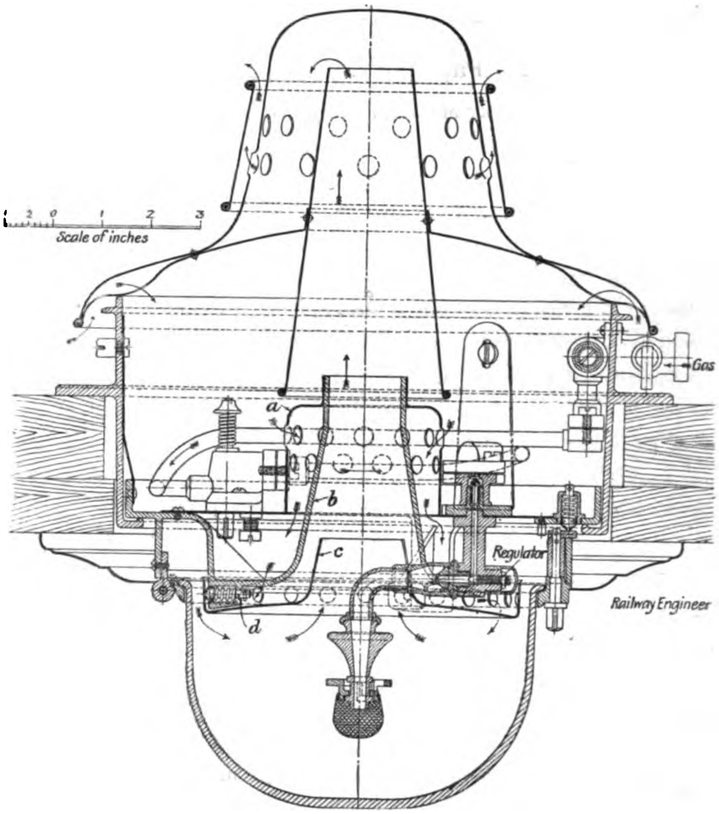


Fig 1.—Pintsch's Patent Roof Lamp with Inverted Incandescent Mantle.

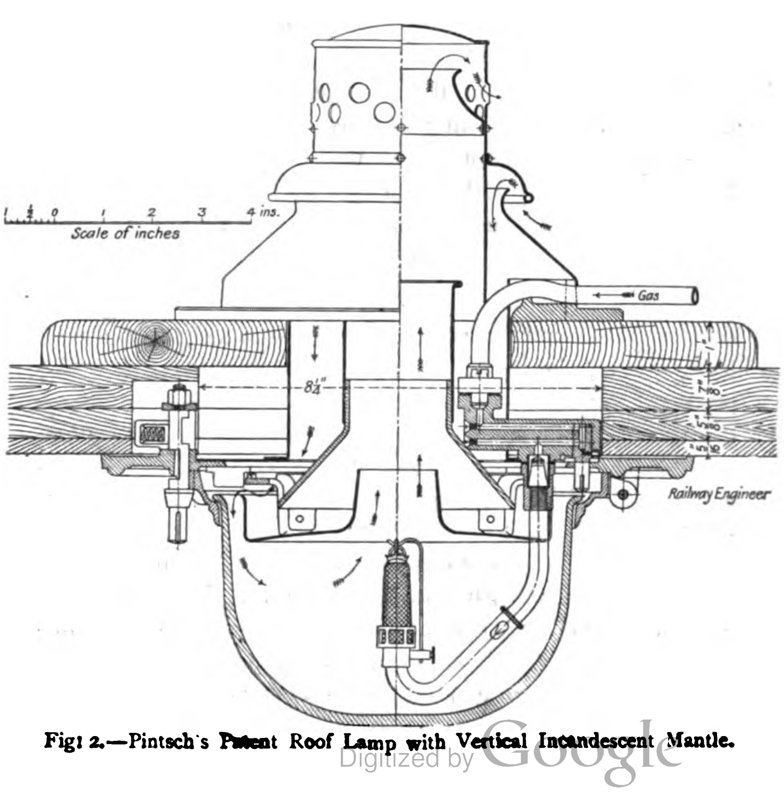


Fig. 2.—Pintsch's Patent Roof Lamp with Vertical Incandescent Mantle.

the fragile nature of the mantles militated against their use for lighting railway carriages. But the manufacture of mantles has improved of late years and the strength of them been very greatly increased, and will, without doubt, continue to do so. Moreover, the mantles required for brilliantly illuminating railway carriages are very small.

On the French railways incandescent mantles have been extensively used with great success, as was pointed out in our issues for October, 1903, and March, 1904, when we illustrated the lamps and burners then in use on the Eastern and the Western railways.

Pintsch's Patent Lighting Co. have now perfected and patented roof lamps and burners for using incandescent mantles. They have had them on trial on the L., Brighton and South Coast and some other railways with such satisfactory results that they were last month able, by the courtesy of Mr. Wm. Forbes, general manager of the L.B. and S.C.R., to exhibit a block train lighted upon this system throughout, and which is the most brilliantly illuminated train running.

Fig. 1 illustrates the lamp, burners, &c., in use on this train. It will be noticed that the mantle is of the "inverted" type, which has the advantage of casting no shadows. The courses taken of the gas and the air are indicated by arrows. The air enters the main chamber and passes through holes in the bell *a* into the regenerative chamber, where it is warmed by contact with the chimney *b*, and out into the combustion chamber by holes round the edge of the reflector *c*, which is held in its place by four spring bolts as shown at *d*. The products of combustion pass up the chimney and out to the atmosphere as indicated by the arrows.

The inverted mantles are protected by a wire cage, which is not made of platinum, but of a cheaper metal. The object of the cage is to prevent the mantle, should it fracture, from falling quite out of the gas flame and leaving the compartment in darkness. The mantles are quite easily taken off or fixed by the asbestos base to which they are attached.

The mantles are sufficiently tough to easily give a life of from one to two months.

The other fittings of the carriage, all of which have been illustrated from time to time in this journal, remain as before, except that the regulator has to be altered and adjusted from a working pressure of between one and two inches of water, at which the present burners work at, to one of about eight inches, which is the pressure which the incandescent burners require.

The economy of this system of lighting is great. An ordinary flat-flame burner of 8 c.p. consumes about one cubic foot per hour, whereas an inverted incandescent mantle, like fig. 1, gives a light of 25 c.p. and consumes only 0·6 cubic ft., or in other words the illuminating power is increased 300% on little more than half the consumption of gas. The effect of adopting this system would, therefore, be to practically double the lighting capacity of all the oil-gas works without altering them in the least. And supposing the present fittings on a carriage enable it to run 30 hours without re-filling the storage tanks it would, by using incandescent mantles, be able to run 60 hours without re-filling. This in itself is not an inconsiderable advantage to railway companies, as it would save a lot of gas-tank haulage, labour, &c., besides being of great advantage during spells of fog.

The new lamp opens from the inside of the carriage for convenience of lighting.

Fig. 2 illustrates the vertical mantle type of burner. In this the mantle is suspended from a wire pillar outside the mantle and fixed to the gallery, which lifts off. The gallery is deep and supports the mantle in case of fracture, so that it remains in the flame until it can be renewed; it also prevents the mantle swinging and breaking itself. This pattern lends itself more readily for alterations.

Rolling Stock for Belgian Light Railways.

In our last issue, pp. 58-60, we gave illustrations and particulars of the types of engines, carriages and wagons in use upon the great system of light railways which spreads all over Belgium, and which is controlled by the *Soc. Nationale des Chemins de Fer Vicinaux.*

These railways are true "light railways," and act as feeders to and distributors from the standard gauge railways of the country. To the agricultural industry they are of inestimable value. Similar light railways exist in every European country except our own, where, of course, the attitude of the local authorities and the Board of Trade renders any attempt to build such railways futile. The trains composed of the vehicles we illustrated steam right into every city and town in Belgium, including Brussels, without hindrance or inconvenience to anyone, but in this country propositions to provide such useful means of transport would probably induce an epidemic of apoplexy among our county and city councillors.

In order to make our descriptions more complete *Mons.* C. de Burlet, *Directeur Général* of the *Société Nationale des Chemins de Fer Vicinaux*, has kindly sent us the following additional particulars respecting his rolling stock :—

Locomotives.

Weight, in working order, metric tons	27	18
Number of wheels, all coupled ...	6	6
	mm.	*mm.*
Cylinders, diam.	350	280
Wheels, diam.	850	832
Fire-box, width, top	1,090	934
Fire-box, width, bottom	700	704
Fire-box, width, length	1,341	1,015
Tubes, number	191	160
	mm.	*mm.*
Tubes, diam. inside	35	35
Tubes, diam. outside...	40	40
	sq. m.	*sq. m.*
Heating surface, tubes	42·02	27·80
Heating surface, fire-box	5·62	4·00
Heating surface, total	47·64	31·80
Capacity of tanks, litres	2,600	2,000
Working pressure, atmos.	12	12

Carriages and Wagons.

The tare weights of the carriages and wagons illustrated in our last issue are as under :—

2nd-class carriages, 4,400 kilos tare ; 3,250 kilos net ; 7,650 kilos gross.

Closed goods wagons, capacity 10 tonnes ; 4,700 kilos.

Platform wagons, capacity 10 tonnes : 3,800 kilos.

High-sided wagons, capacity 10 tonnes ; 4.200 kilos.

20 tonnes bogie wagons for transporting main-line wagons on their wheels so as to avoid transhipping the load, 6,500 kilos.

Notes on Old Railway Bridges.

SINCE the opening of the earlier railways the increasing loads of locomotives have necessitated many changes in the bridges under the line.

The bridges as they stand to-day are probably of quite different types to the original constructions, yet they often consist, in part, of the original girders augmented by additional girders of either cast or wrought iron or of steel, according to the period at which strengthening became necessary. This economical system of strengthening the old bridges instead of completely renewing them has had an effect in influencing the design of modern railway bridges, and a brief review of some of the alterations which have taken place is not without interest.

Speaking of bridges up to say 30 ft. span, a very usual construction consisted of two cast iron girders to each road, the track being laid on cross planking. The half cross section of a bridge of this type carrying two roads is sketched in fig. 1.

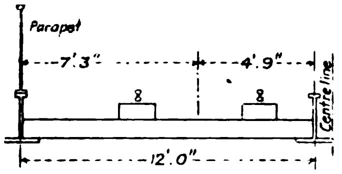


Fig. 1.

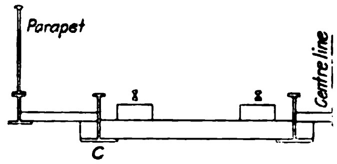


Fig. 2.

The girders would probably be of the same section, with perhaps the addition of some ornament on the face of the parapet girder.

An objection to this arrangement is that the inner girders, being nearer to the rails than the face girders, would be unduly strained, and with the dimensions figured on the sketch the inner girder would carry

$$7{\cdot}25 \div 12 \times 100\% = 60\%$$

of the moving load.

Also the floor, having probably been designed for a certain load per square foot of area, would be of insufficient strength to support the heavy loads on the driving wheels of modern locomotives unless the rail timbers were of such stiffness as to distribute the loads over a considerable width of the floor.

These defects in bridges of this type have been remedied from time to time in several ways.

A construction very commonly occurring is that sketched in fig. 2, and there is often evidence either in ornament or in bolt holes no longer used, to show that the girder marked *c* was originally under the parapet. Very probably the construction was formerly similar to that shown in fig. 1, and in order to divide the load equally between the two girders, or to strengthen the floor, or for the two reasons combined, the girders have been brought closer together, the floor planks cut to the required length, and the parapet carried on a girder of lighter section.

By thus modifying the original structure the moving load on the weaker girder has been reduced by

$$(60\% - 50\%) \div 60\% \times 100\% = 17\%$$

The span of the floor beams has also been considerably reduced.

Another form of cast iron bridge often seen is of the same type as fig. 1, with an additional girder of cast or wrought iron in each four-foot. These girders are necessarily of heavier section than those originally included in the structure and have very likely been taken out of another bridge. They can generally be recognised as additions either by holes for which there is no use in the present structure or by an end having been cut to make the length of the girder suitable to the span.

The position of the additional girder in fig. 3 is that which causes an equal portion of the moving load to be carried by each of the old girders, the proportion being

$$1{\cdot}6 \div 3{\cdot}85 \times 50\% = 21\%$$

The additional girder therefore has to carry 58 per cent. of the moving load, or nearly as much as the inner girder previous to strengthening, and in order that the bridge may be uniformly strengthened the girder added, if of cast iron, must be of considerably larger section than those already in the bridge. It is probable that this method of strengthening, when used, has been as much on account of a weak floor as of weakness in the girders.

In other cases, possibly, in which strengthening was not necessary at such an early period, the inner girders will be found replaced by girders of wrought iron, the face girders of cast iron remaining in the bridges. In such instances the floor will generally be found to consist of good deep timbers, from which it may be inferred that either the original floor was of sufficient strength or that there was depth enough to renew the old floor with beams of deeper section.

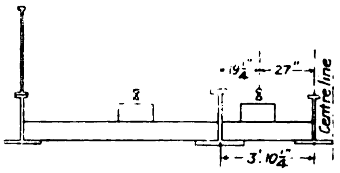


Fig. 3.

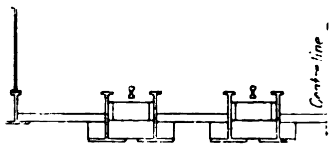


Fig. 4.

Another construction of cast iron girders often met with consists of four girders under each road, each rail being laid in a trough composed of two girders. The half section of a bridge of this type is shown in fig. 4. It is very usual in bridges of this description to find the girders under the up road different in section to those under the down road, or even to find this construction under one road and some arrangement of wrought iron girders under the other. The obvious conclusion in cases where the two lines are known to have been constructed simultaneously is that the original bridge contained four girders only, very probably arranged in the manner shown in fig. 1, and that the present arrangement is the result of subsequent strengthening.

The convenience of this arrangement becomes evident whenever it is necessary to take girders of this sort out of a bridge and replace them by others. As the girders under each rail are independent, the work of reconstruction can be carried out without much delay to the traffic.

At the present day cast iron is not considered a suitable material to resist tension, and the general practice is to renew cast iron girder bridges in wrought iron or steel. The material is altered but the type often remains the same, and wrought iron or steel trough girders, similar in principle to those sketched in fig. 5, are very commonly employed for bridges of ordinary span.

The earlier wrought iron bridges constructed of trough girders have timber floors, but plate floors, whch have the great advantage of being watertight, are generally used in modern practice.

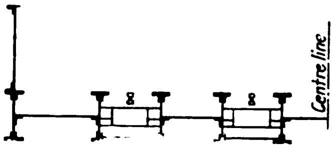


Fig. 5.

In low lying counties liable to floods there are many bridges, serving the purpose of flood openings, in which the headway is not important. Such bridges were often built on the deck principle, the floor planks being laid across the top flanges of the girders, which were generally of I section.

The strengthening of this class of bridge has been carried out in much the same way as that already described.

The girders have first been brought closer together and others added, and finally replaced by plate girders of either wrought iron or steel.

The floor, too, has very generally been replaced by one of watertight construction, consisting of jack arches turned from the lower flanges of the girders, backed with cement concrete and covered with a layer of asphalt.

There seems to be considerable divergence of opinion in the ideas of bridge engineers concerning this construction. Some regard it as antiquated and unnecessarily heavy, while others find in it the best means of protecting ironwork from corrosion, and adopt this type of floor whenever a sufficiency of headway renders it practicable.

In the earlier days of railway engineering the use of cast iron was not confined to bridges of the spans referred to. For spans up to about 60ft. girders were built up of sections of cast iron, bolted together and trussed with wrought iron tie rods. The depth of these girders would not permit of duplication under each line, even had it been considered desirable to perpetuate girders of this type, and bridges in which they occurred have very generally been renewed in a construction of main and cross girders of wrought iron or steel plate.

Bridges of still larger span up to and over 100 ft. were constructed of cast iron arched ribs. In some cases, generally in the smaller spans, the thrust would be taken by wrought iron rods, producing a bow string girder, while in others the thrust would be resisted by the abutments.

For girders of this description cast iron is quite a suitable material, as it is only strained in compression, and such alterations as have been made in bridges of this type have chiefly consisted of strengthening the floor and stiffening the bridge laterally.

When it has been necessary to widen arched bridges or to strengthen them, additional ribs have been built up of wrought iron or mild steel plate and other rolled sections, on the model of the existing ribs, so that here again the old design has had an influence upon the new.

40-Tons "Cantilever" Coal Wagons; Great Central Railway.

In our issue for last November we published a short description, accompanied by views, of these interesting high-carrying-capacity wagons which Mr. J. G. Robinson, M. Inst. C.E., chief mechanical engineer of the Great Central R., designed for his company's "domestic" use, or, in other words, for the carriage of the coal consumed in his department.

These wagons were built by the Birmingham Railway Carriage and Wagon Co., Ltd., Smethwick, and are constructed upon the "cantilever" principle under the Livesey-Gould patents. They are an enlargement of the 30-tons capacity "cantilever" coal wagons which we illustrated in our issue for last April, and a comparison of the drawings we then published with those which, by the courtesy of Mr. J. G. Robinson, we are now able to present to our readers will, we are sure, prove very interesting.

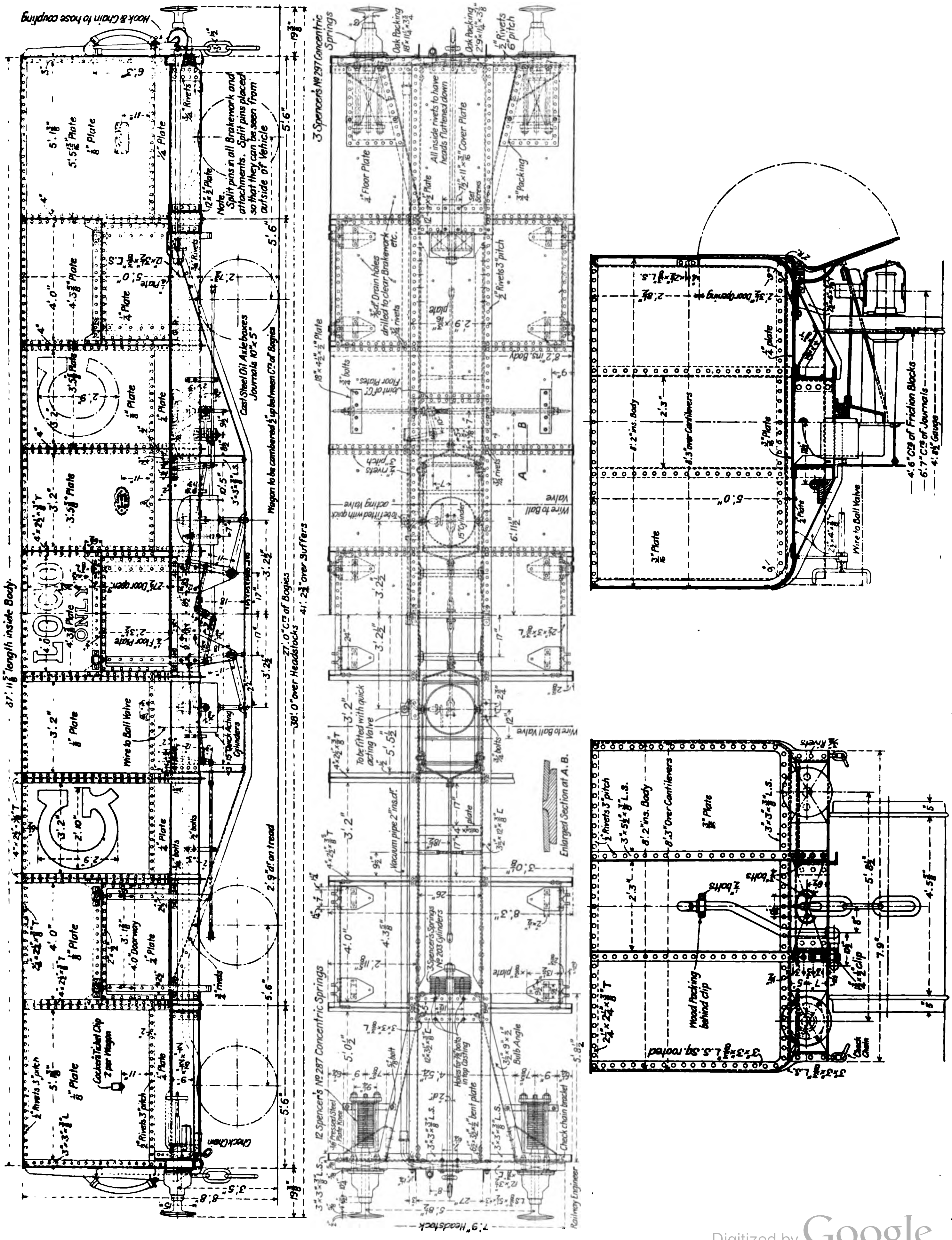
The experience Mr. Robinson had with the smaller size led him to the conclusion that he could design a wagon with the same length and wheelbase of nearly the same tare weight, but having 33·3 per cent. greater carrying capacity, and this he has been able to do, for whereas the tare of the 30-tons wagons is 13 tons 11 cwts., that of the 40-tons wagons is only 14 tons 19 cwts. The difference in the height of the wagon is but 8 ins., and in the width over the stanchions 3 ins., but in connection with this latter dimension it should be noticed that the width inside has been increased by 7¼ ins. This has been accomplished by turning the legs of the T's towards the inside instead of the outside, and which economises the width to the utmost extent. In coal wagons the vertical ribs down the inner sides of the body is a matter of no consequence, but across the bottom they would, of course, interfere with the unloading, and they are therefore cut off as shown in the cross section and at A B on the plan.

The chief dimensions are:—

Length over the buffers, 41 ft. 2¾ ins.
Length over the headstocks, 38 ft.
Length between centres of bogies, 27 ft.
Length of body inside, 37 ft. 11⅝ ins.
Wheelbase of bogies, 5 ft. 6 ins.
Width over "cantilever" frames, 8 ft. 3 ins.
Width of body inside, 8 ft. 2 ins.
Height of top of sides above rail, 8 ft. 8 ins.
Height of body inside, 5 ft.
Thickness of side plates, ⅛ in.; end plates and middle plate $\frac{3}{16}$ in.
Side floor plates, ¼ in.
Tare weight, 14 tons 19 cwts.

There are three discharging doors on each side, giving clear openings 4 ft. × by 2 ft. 3½ ins. The door frames are 2 ins. by ½ in., and the panel plate ¼ in. thick.

The central member, or backbone as it might be called, consists of two steel channels 12 ins. × 3½ ins. × ⅜ in. placed back to back 26 ins. apart running from headstock to headstock, and to which they are connected by bent ½ in. plates 6½ ins. × 3½ ins. × 12 ins. These channels are joined together on top by the middle floor plate, which is in three lengths and is riveted to the top flanges with ½ in. rivets at 3 ins. pitch. They are also connected by the "cantilevers" or ribs of steel T's, 4 ins × 2½ ins. × ⅜ in., which pass underneath them to the turn of the sides, where



40-Tons "Cantilever" Coal Wagon; Great Central Railway.

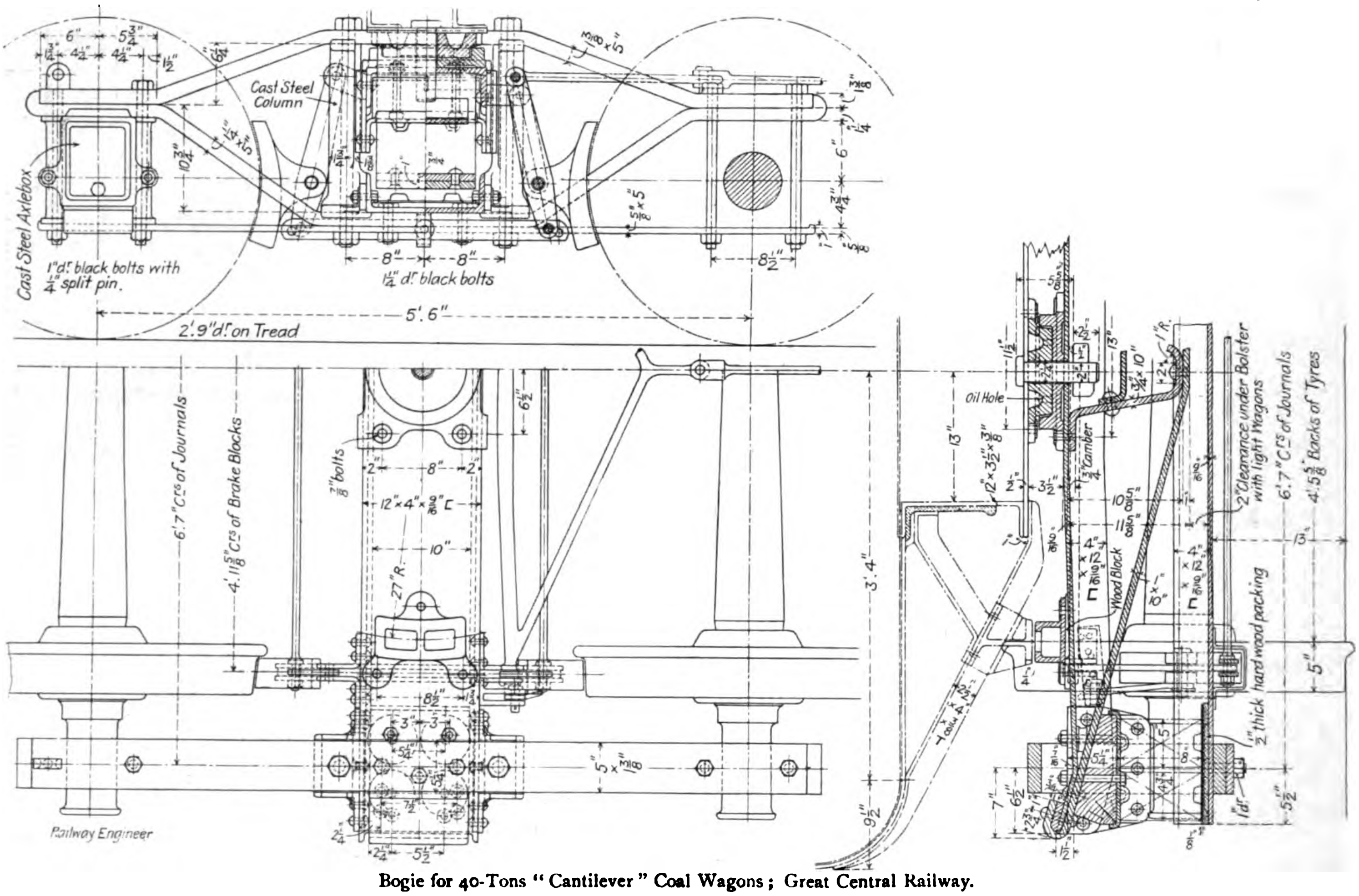
they are joined to other T's turned the other way and which run up the sides, and form the stanchions as previously mentioned. The bogie centre bearers consist of two lengths of channel, 12 ins. × 3½ ins. × ⅜ in., riveted to the floor plate and covered on the lower flanges by a steel plate 12 ins. × ½ in. and connected to the longitudinals by 3 ins. × 3 ins. × ⅜ in. steel angles.

The longitudinal channels are trussed by two steel angles, 3 ins. × 3 ins. × ⅜ in., riveted to them between the bogie-centre bearers and carried over two frames of angles of the same section as shown, the depth of the queen truss being 18 ins. clear between the flanges.

The headstocks, steel channels 12 ins. × 3½ ins. × ⅜ in., are raised above the level of the central longitudinal girder owing to the necessity of maintaining the standard height for ½ in., have been splayed out from the longitudinals at the bogie-centre bearers, on which the draw-bar pulls, to the headstocks behind the buffers, the bend in the bulb-angle being stiffened by pressed steel knees of ⅜ in. plate.

The buffers were especially designed by Mr. Robinson for this class of under-frame and were illustrated in detail in our issue for last April. They are of the compound type and contain two sets of Spencer's patent concentric rubber springs, the smaller of which absorb the ordinary buffing shocks, while the larger ones only come into operation during violent shunting or when the buffer heads are driven home. Owing to the lowness of the floor of the wagon the buffer springs project through the floor and are covered with dished floor plates as shown.

The draw-bar is 2 ins. diam. and is fitted with Spencer's



Bogie for 40-Tons "Cantilever" Coal Wagons; Great Central Railway.

the buffers and draw-hook. Their backs are turned inwards and their flanges filled with oak packing to give proper seating for the flanges of the buffer casings and for the draw-bar plate. A frame of angle steel, 3 ins. × 3 ins. × ⅜ in., is riveted under the top flange of the headstocks and carried up the sides to receive the side and end plates and form the corners of the wagon body. A steel T 3½ ins. × 3½ ins. × ⅜ in. is carried all round the inside of the top of the sides and ends of the body and makes a neat and strong finish with practically no overhang. The end plates are stiffened by two steel angle stanchions, 3 ins. × 5½ ins. × ⅜ in., tapering towards the top.

To adopt this construction of under-frame for side-buffered stock special provision has to be made for transmitting the buffing strains to the central member, and in the wagons under notice steel bulb-angles, 3½ ins. × 9 ins. × india-rubber cylinder springs as shown. The coupling chains are of 1½ ins. diam. iron.

These wagons are provided with the "rapid acting" vacuum automatic brake and also with a horizontal screw hand brake operated from either side. The arrangement of the two 15 ins. brake cylinders and the rigging is clearly shown. With regard to the brake gear it will be noted that this style of under-frame lends itself very readily for the necessary attachments

The bogies are of the "diamond" type, the wheels being 2 ft. 9 ins. diam. on the tread.

The journals are 10 ins. × 5 ins. and are 6 ft. 7 ins. centre to centre.

The axle-boxes are of cast steel and their bolts 1 in. diam. at 8 ins. centres.

The springs are in nests of four on each side, the outer pairs being $4\frac{3}{4}$ ins. diam. and the inner pairs 5 ins. diam.

The column is of cast steel, and the column bolts $1\frac{1}{4}$ ins.

The spring plank is a steel channel 4 ins. × 12 ins. × $\frac{9}{16}$ ins.

The diamond frame is composed of iron bars 5 ins. × $1\frac{3}{4}$ ins., $1\frac{1}{4}$ ins., and $\frac{5}{8}$ in. thick respectively, the ends being hooked so that there is no shearing strain on the axle-box bolts.

The bolster consists of a truss, the top member being a steel channel frame section as that of the spring plank, and the lower member is an iron plate 10 ins. × 1 in. hooked over the ends of the channel and passing under a deep pressed iron plate under the centre pin, which is $2\frac{1}{4}$ ins. diam.

The centre is composed of two steel castings with flat bearing surfaces as shown. The friction blocks are also steel castings and are placed 4 ft. 6 ins. from centre to centre.

Features of Continental Goods Engines.

BETWEEN the Continental and British types of locomotives intended for the haulage of goods and mineral trains there are not many points in common, and in view of the varied conditions and enormous mileage existing on the one hand and the more or less uniform conditions surrounding the other, this is only to be expected. Allowance must also be made for the personal factor—a very strong one—for no two engineers, especially of radically different training, will produce the same style or even type of locomotive for the same or very similar work, hence there are many more varieties of types to be found in Continental than in British practice, and in spite of the seemingly unnecessary complications there are many highly successful designs in service.

The cylinders are usually placed outside the frames, the reasons for this being (other than custom) that the scarcity of pits on the lines and in the steam sheds renders the underneath of the engine very inaccessible, also that in the case of two cylinder compounds it has become practically impossible to get the large low pressure cylinder alongside the high pressure between the frames. A large percentage of all the different types have the valve gear outside the frames, not only where the Walschaërt gear is preferred, but also where the Stephenson link is used. In consequence of this position of the valve gear the steam chests are on the top, which arrangement certainly presents the advantage of giving ready access to the valve faces, and slide valves, without the interposition of rocking shafts, as in American practice.

In the design of boilers, it is the details of construction, more than the types, that are markedly different, though to some extent the type also is a feature. Thus in the most engines in Belgium and France the Belpaive firebox is predominant, while in Germany and Central Europe the round top firebox practically excludes all other types, but the fireboxes are always direct stayed. Steam domes are general, in fact so much is this the case that some engineers, especially in Austro-Hungary, fit many of the boilers with two connected to each other by a large pipe, but it is doubtful whether anything is to be gained by this arrangement.

Although the 0-6-0 type is not used to anything like the extent to which it was formerly, yet several railways still have numbers of engines of this type at work of recent build, mostly with outside cylinders, though some on the Belgian States R. and the Eastern R. of France, for example, have inside cylinders and outside frames, as illustrated by fig. 1. The general proportions are very similar to modern home-built goods engines of the type; the cylinders are 18·5 ins. by 25·59 ins.,

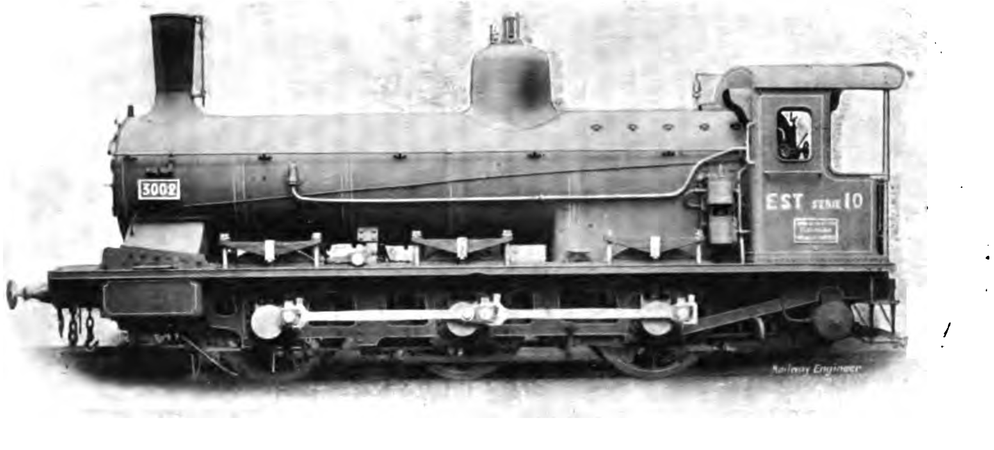


Fig. 1.

One of the most striking features is the extent to which compound cylinders are used. But while in nearly every different country a different system is to be seen—embodying two, three or four cylinders—there is a commendable uniformity in respect of the ratio of the high pressure to the low pressure cylinder volume, the average being about 1 to 2·24. All the various systems are reported as being economical in working and reliable; this is especially interesting when the scarcity of compound goods engines in home practice is borne in mind.

with the valves beneath operated by Stephenson link motion; the wheels are 4 ft. 7·9 ins. diam. on the tread, on a wheelbase 13 ft. 10·14 ins., the overhang of the frames at the rear end is considerable, being 8 ft. 7 ins. The boiler barrel is in three rings, 4 ft. 8.3 ins. mean diam. by 12 ft. 9·5 ins. between tube plates, and it has 190 tubes 1·57 ins. diam. The firebox is round topped, 8 ft. 2·4 ins. long by 4 ft. wide; the grate area is 27·88 sq. ft.; the heating surface of the tubes is 1,282·3 sq. ft., and of the firebox 126·26 sq. ft. In working order the weight is 47 tons 6 cwts. 2 qrs.

The extent to which each separate type has become identified with individual countries is no doubt largely due to the general character of the lines, thus the 0-8-0 type is preeminently the type in France, although great numbers are used on the Italian and German lines; the 2-8-0 engine is representative of the practice of Central Europe; as for the "mogul" or 2-6-0 type, it cannot be allocated, for in practically all countries it is the "utility" machine.

The Prussian States R. have a standard class of "moguls" as shown by fig. 2, and nearly all the German builders have constructed engines of this type. It is a plain straightforward engine, redolent of German practice, the cylinders are compound, 19·68 ins. and 29·5 ins. diam., with a stroke of 24·8 ins. The high pressure cylinder is on the right-hand side; a Von Borries starting valve fitted with a by-pass to delay the compounding until the wheels have made a few revolutions (about 10) is used. The valve gear is Welschaërt's.

The total wheelbase is 19 ft. 8·2 ins., the rigid base is only 5 ft. 4 ins., owing to the use of the "Krauss" truck formed by the leading carrying and coupled wheels, an arrangement very common in German locomotives, and reported to give very satisfactory service; the wheel diameters are—leading, 3 ft. 3·37 ins., coupled, 4 ft. 5·14 ins. The boiler has a round topped firebox 8 ft. 45 ins. long by 3 ft. 11·24 ins. wide; the inside firebox is of copper, 7 ft. 4·57 ins. by 3·37 ins.; the grate area is 24·22 sq. ft.; the boiler barrel is 5 ft. 0·24 ins. mean diam. and 13 ft. 6·35 ins. long; there are 217 tubes, 2 ins. diam, with a heating surface of 1,577·64 sq. ft.; the working pressure is 172 lbs.; the weight in working order is 43 tons, the adhesive weight is 32 tons 7 cwts.

Several years ago the Northern R. of France experimented with a three-cylinder compound engine having one high pressure and two low pressure cylinders; the class was not, however, perpetuated; however, on the Jura-Simplon R., Switzerland, there is a numerous class of "moguls" compounded on the three cylinder system; there is one high pressure and two low pressure cylinders; the high pressure cylinder is between the frames underneath the smokebox, driving the leading coupled axle; the low pressure cylinders are outside the frames just in front of the leading coupled wheels; the middle pair of coupled wheels are driven by these cylinders; all the driving wheels are coupled; the high pressure cylinder is 19·68 ins. by 23·62 ins., inclined 1 in 20, the low pressure cylinder being 21·26 ins. by 23·62 ins. All the valves are above the cylinders, and are operated by the Welschaërt gear, the valves are of the Allan-Trick pattern. The coupled wheels are 11·83 ins. diam., bogie wheels 2 ft. 9·46 ins.

The boiler has a total heating surface of 1,510·2 sq. ft.; the firebox surface is 132·4 sq. ft., with a grate area of 24·76 sq. ft; the weight in working order is 53 tons 18 cwts., of which 43 tons 16 cwts. is available for adhesion; the bearing springs are all compensated, the truck and springs of the leading coupled wheels being in connection.

With regard to the 0-8-0 type, it has already been said that it is characteristic of the French railways, yet it would be very difficult to find a country not having representatives of it, for it possesses the advantage of all its weight being available for tractive purposes, combined with simplicity and low first cost as compared with bogie engines; it is not very well adapted for high speeds, although some very creditable running with fast goods trains can be placed to its account, and as a general type for heavy work it is hard to equal. Among the most recent examples to be found in all countries the majority are compounds; indeed, in France this system came early into vogue and has ever since made great strides. The majority have four cylinders, sometimes driving on to two axles, but more commonly on to one. The engine illustrated by fig. 3 belongs to the Paris, Lyons and M. R., and is a good example of this type.

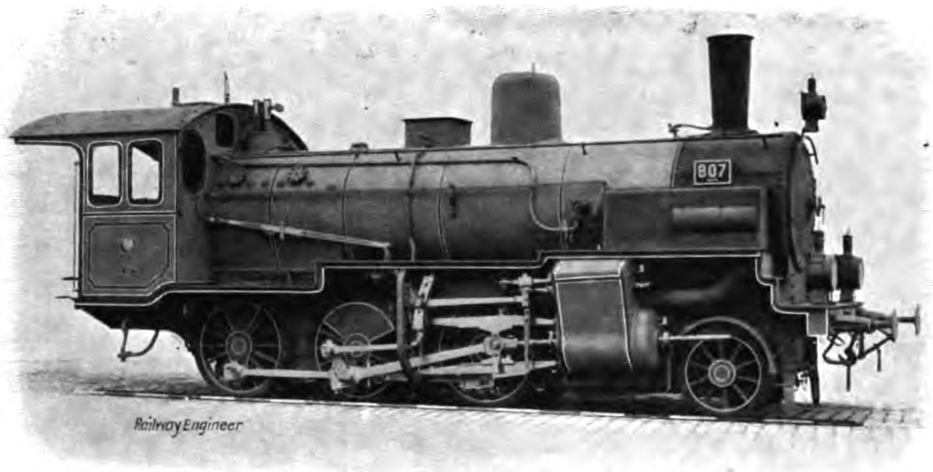


Fig. 2.

The boiler is of liberal proportions, having 2,183 sq. ft. of heating surface, with a grate area of 22·6 sq. ft.; the working pressure is 213 lbs. per sq. in.; the boiler barrel is short, being 10 ft. 1 in. between the tube plates; the tubes are of the Serve pattern; the barrel is built in two rings, the rear being coned; the dimensions are 4 ft. 11 ins. and 5 ft. 2·9 ins.; the firebox is 8 ft. long. All four cylinders are placed side by side, the high pressure ones, which are outside the frames, being horizontal with the valve chests above; the low pressure cylinders are inclined, with the valve chests below. The valves are all actuated by the Walschaërt gear, which for

the low pressure valves is inverted, a rather unusual arrangement. The high and low pressure gears have separate wheels on the footplate for independent adjustment. And a starting valve is provided.

The cylinder dimensions are 13·5 ins. and 20·5 ins. by 25·2 ins. The cranks on each side are set at 180°, those on the opposite side bisecting these angles. The wheels are 4 ft. 3·5 ins. diam., on a wheelbase of 15 ft. 8 ins.; the springs for the driving axle are above the axle-boxes; the trailing springs are underhung; compensating levers are fitted between the leading and driving axle. When loaded the weight is 52 tons.

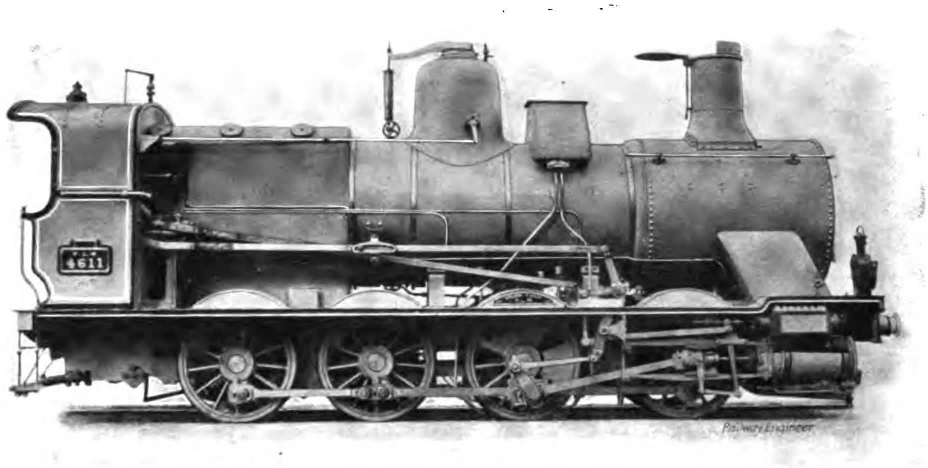


Fig. 3.

In Germany the two-cylinder system of compounding is supreme, being fitted to all types of goods engines; the Von Borries automatic starting valve is used. The particulars of one of the Prussian State R. 0-8-0 engines are as follows: Cylinders 20·86 ins. and 29·5 ins. by 24·8 ins. stroke; the slide valves, Allan-Trick, actuated by the straight link motion; the wheels are 4 ft. 11 ins. diam., the wheelbase 14 ft. 9·13 ins., the springs, underhung, compensated for the driving and trailing axles. The boiler is flush topped, the surface of the tubes 1,395 ft., and of the firebox 113 sq. ft; the area of the grate is 23·7 sq. ft. The weight loaded is the same as for the P.L.M. engines, namely, 52 tons, fairly evenly distributed.

For the railways of Central Europe and Southern Germany where the gradients are severe and the curves sharp, engines having a more flexible wheelbase are essential; for heavy goods traffic the 2-8-0 type is much used. In Saxony and Austria the two-cylinder compound is favoured, while in Bavaria and elsewhere the simple engine is still in vogue; a fine example of these last is illustrated by fig. 4, which shows one of the Bavarian States goods locomotives. It is very powerful, having cylinders 21·26 ins. by 22·05 ins. stroke, driving on to the third of the coupled axles; the valves are above the cylinders, actuated by Walschaërt valve gear; the coupled wheels are 3 ft. 10·06 ins. diam.; the bogie wheels are 3 ft. 3·2 ins. diam; the leading coupled and carrying wheels form a "Krauss" truck, reducing the total wheelbase of 22 ft. 11·6 ins. to 9 ft. 2·24 ins. rigid base; the boiler barrel is 5 ft. 3 ins. diam. by 14 ft. 5 ins.; there are 229 tubes of 2·05 ins. diam.; the firebox is round topped, 7 ft. 8·5 ins. long by 3 ft. 4·2 ins. wide inside; the grate area is 26 sq. ft.; the tubes, heating surface is 1,937 sq. ft. In working order the weight is 63 tons 11 cwts 2 qrs.; on the coupled wheels 53 tons 14 cwts. 3 qrs.; on the leading truck 9 tons 16 cwts. 3 qrs.

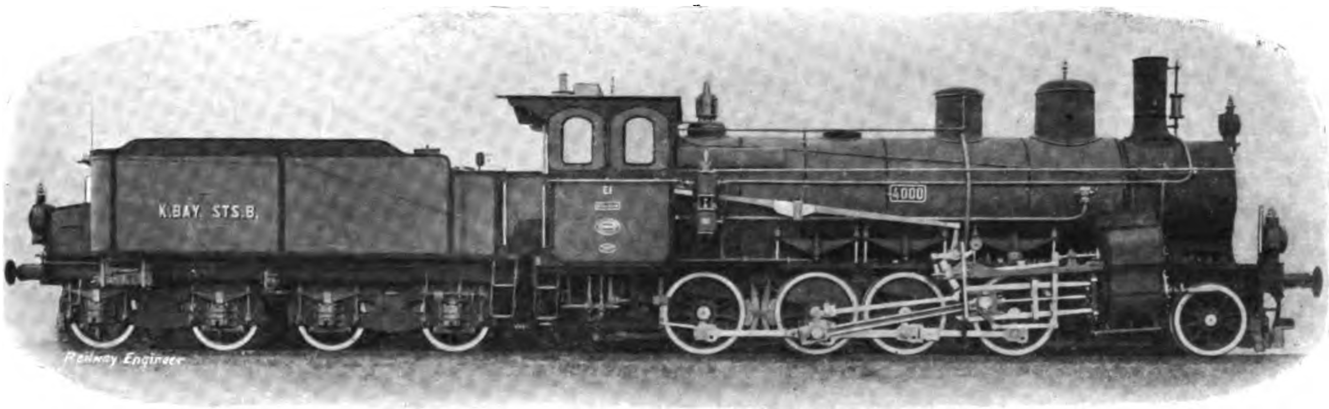


Fig. 4.

On the Austrian States R. there is a class of enormous 2-8-0 engines, compounded on the Golsdorf system, with cylinders 21·25 ins. and 31·5 ins. diam. by 24·8 ins. stroke. The coupled wheels are 4 ft. 1½ ins. diam.; the leading end is carried by a radial axlebox, the wheels of which are 2 ft. 8¾ ins. diam., with a side play of 2½ ins. on each side; the second and fourth coupled axles have also considerable play.

The heating surface, 2,690 sq. ft., at first appears out of proportion to the cylinders, but the fuel is of a very poor quality. The 275 tubes, which are 2 ins. diam., give 2,539·4 sq. ft., and the firebox 150·6 sq. ft.; the grate area is 36·1 sq. ft. In running order the weights are, adhesive, 56 tons 2 cwts. 1qr.; total, 67 tons 8 cwts.

(To be continued.)

Railways and the Board of Trade.—III.*

(Continued from page 52.)

THE following are the requirements of the Board of Trade as to the methods of

Working Single Lines.

In the case of a line being single, an undertaking must be sent to the Board of Trade, through the inspecting officer, to the effect that one of the three following methods of working single lines will be adopted, namely :—

I.—By train-staff and train-tickets in the mode described in the following rules, combined with the absolute block telegraph system :—

Rules for Working the Single Lines between A.B.C., &c.

1. Either a train-staff or a train-ticket is to be carried with each engine or train, to and fro, and for this purpose (one, two or more) train-staffs and sets of train-tickets will be employed, *e.g.*,

	Colour of Staff and ticket.	Form of Staff and ticket.
One between A and B... ...	Red	Square
One between B and C... ...	Blue	Round
etc. etc.	etc.	etc.

2. No engine or train is to be permitted to leave or pass either of the staff stations A, B, C, etc., unless the staff for the portion of line over which it is to travel is then at the station; and no engine-driver is on any account to leave or pass a staff station without seeing such train-staff.

3. If no second engine or train is intended to follow the train-staff is to be given to the engine-driver.

4. If other engines or trains are intended to follow before the staff can be returned a train-ticket stating "staff following" is to be given to the engine-driver of the first engine, and so on with any other except the last, the staff itself being sent with the last. After the staff has been sent away, no other engine or train is to leave the staff station under any circumstances whatever until the return of the staff.

5. The train-tickets are to be kept in a box fastened by an inside spring, and the key to open the box must be the train-staff, so that a ticket cannot be obtained without the train-staff. The removal of the train-staff must lock the box.

6. The train-staffs, the train-tickets, and the ticket-boxes are to be painted or printed in different colours, *e.g.*, red for the line between A and B, blue for that between B and C, etc., the inside springs and the keys on the staffs being so arranged that the red staff cannot open the blue box, or the blue staff the red box, and so forth.

7. The ticket-boxes are to be kept in the signal cabins or in the booking offices at the staff stations.

8. The sole person authorised to receive, exhibit, or deliver the staff or ticket is either the station master, the inspector, the signalman, or the person in charge for the time at a staff station.

9. The usual special train tail signal, "engine or train followmg," must be used by every engine or train carrying a ticket for the information of the platelayers, gatekeepers and others.

*No. I. appeared in the January issue and No. II. in the February issue of the *Railway Engineer.*

10. When a ballast train has to do work on the line, the staff only and no tickets to be used by such train. This will close the line while the ballast train is at work. The ballast train must proceed to one of the two staff stations in order to open the line before the ordinary traffic can be resumed.

11. In the event of an engine or train breaking down between two staff stations, the fireman or guard is to take the train-staff, if with the train, to the staff station in the direction when assistance may be expected, so that the staff may be at that station on the arrival of an engine. Should the engine or train that fails be in possession of a train-ticket instead of the staff, assistance can only come from the station at which the train-staff has been left. The fireman will accompany any assisting engine to the place where the engine or train broke down.

II.—With only one engine in steam, or two or more engines coupled together, upon the single line or any section thereof at one and the same time.

Such engine or engines to carry the staff belonging to the line or section on which the train is travelling.

(N.B.—No tickets to be allowed under this mode of working.)

III.—By the electric tablet or electric staff system, under which only one of the tablets (or staffs) applying to any section can be in use at the same time.

(N.B.—The approval of the Board of Trade to be obtained for the apparatus proposed to be used, and for the rules of working, which should be of a somewhat similar character to those detailed under mode of working, No. I.).

The Recommendations of the Board of Trade as to the Working of Railways are :—

1. There should be a brake vehicle with a guard in it at or near the tail of every passenger train; this vehicle should be provided with a raised roof and extended sides, glazed to the front and back, and it should be the duty of the guard to keep a constant look-out from it along his train.

2. All passenger carriages should be provided with continuous footboards extending the whole length of each carriage and as far as the outer end of the buffer castings. As passenger carriages pass from one company's line to another's, it is essential for the public safety that although the widths of the carriages on the different lines may differ from each other the width across the carriages from the outside of the continuous footboard on one side to the outside of the continuous footboard on the opposite side shall be identical for the carriages of all the railway companies, so that the lines of rails may be laid at the proper distance from the edges of the passenger platforms.

3. There shall be efficient means of communication between the guard or guards of every passenger train and the engine-driver and between the passengers and the servants of the company in charge of the train.

4. The tyres of all wheels should be so secured as to prevent them from flying open when they are fractured.

5. The engines employed with passenger trains should be of a steady description with not less than six wheels, with the centre of gravity in front of the driving wheels and with the motions balanced. They should, as a rule, be run chimney in front.

6. Records should be carefully kept of the work performed by the wearing parts of the rolling stock, to afford practical information in regard to them and to prevent them from being retained in use longer than is desirable.

7. In addition to the block-telegraph instruments, it is desirable that there should be speaking instruments or telephones for communicating between signalmen and books for recording the running of the trains.

8. When drovers or other persons are permitted to travel with goods or cattle trains, suitable vehicles should be provided for their accommodation.

9. Refuge sidings should be provided at all main line stations where slow trains are liable to be shunted for fast trains to pass them. If at such stations it is impossible to provide refuge sidings and slow trains have to be shunted from one main line to the other to allow of fast trains passing them, some simple arrangements should be supplied in the signal cabins to help to remind the signalman of the shunted train.

10. Efficient means to be adopted to prevent the accidental opening of the doors of passenger carriages.

All the necessary plans and documents as to the new line having been sent to the Board of Trade, an inspector is appointed and an advice to that effect is sent to the Railway Company.

The inspecting officer communicates direct with the General Manager, Secretary or Engineer, advising him when the inspection will be made.

As a rule the inspector will walk over the line in one direction, a carriage being drawn slowly in front with a door open on the near side, the purpose of which is to quickly draw attention to any structure that is too near the running line.

The inspector will look at all culverts and see that they retain their shape, and all under-bridges will be tested by two of the heaviest engines standing on the bridge on each line and afterwards running over the bridge. By these tests the deflection is obtained.

He will, whilst walking, carefully watch the permanent way and works, making enquiries as to any embankments or cuttings that may have given trouble during construction or are likely to give trouble. He will see that the rails are keyed and the chairs secured, that two connected rods are provided for each switch and a gauge-tie for every facing point, and that the angle of all crossings is not too obtuse.

Stations are looked over and it is ascertained that accommodation is provided for both sexes, that there is a clock, also station name-boards, sufficient lighting, etc.

The inspector will notice that mileage posts and gradient boards are erected, and that, on gradients steeper than 1 in 260, runaway catch points in suitable positions are provided to intercept any vehicles that may break loose and run back in a facing direction.

The testing and examination of the signalling and interlocking takes some time.

The inspector will go into the signal-box and see that the signalman has a good view of the line, that the signals stand in such positions that they protect trains efficiently, also that trains standing at them can be seen from the signal-box. He will make sure that all signals that cannot be seen by the signalman are provided with electrical repeaters.

The interlocking is carefully tested and the inspector sees that all conflicting points and signals are interlocked.

He will see that the necessary block instruments are provided, also a clock.

All this and much more is done by the inspector in the case of new lines

Where an alteration is made in an existing line the foregoing details are not necessary. All that need be sent to the Board of Trade then is a plan of the place showing in red the alterations that have been made. On the plan must be shown the signals, and the signal-boxes affected and details of the duties of each lever. The gradient diagram must also be shown on the plan.

It is desirable to offer to the Board of Trade not only the works already referred to but all new signal-boxes, new locking frames and places where the signal arrangements are re-modelled, so that the stamp of approval of the Board of Trade may be upon them.

Some companies do not regard the Act as applicable to temporary works, but it is better that such should be submitted. The inspecting officers are most reasonable and will not make any unnecessary demands on a railway company if the case be submitted to them.

Included in such works are single-line working during re-construction of a bridge, and temporary works in connection with new stations, etc.

When any extensive works are being carried out and some temporary alteration has to be made to a passenger line or some of the work brought into use piecemeal a copy of the plan—a copy of the Parliamentary plan will do—should be sent to the Board of Trade asking for provisional sanction to bring the works into use from time to time as may be required. Then when the whole work is completed it should be offered for inspection, the provisional section being quoted when the Board of Trade is written to. If any part of the work can be inspected from time to time it should be done, otherwise bridges and roads will be run over and signalling, etc., be in work that have not been passed by the Board of Trade.

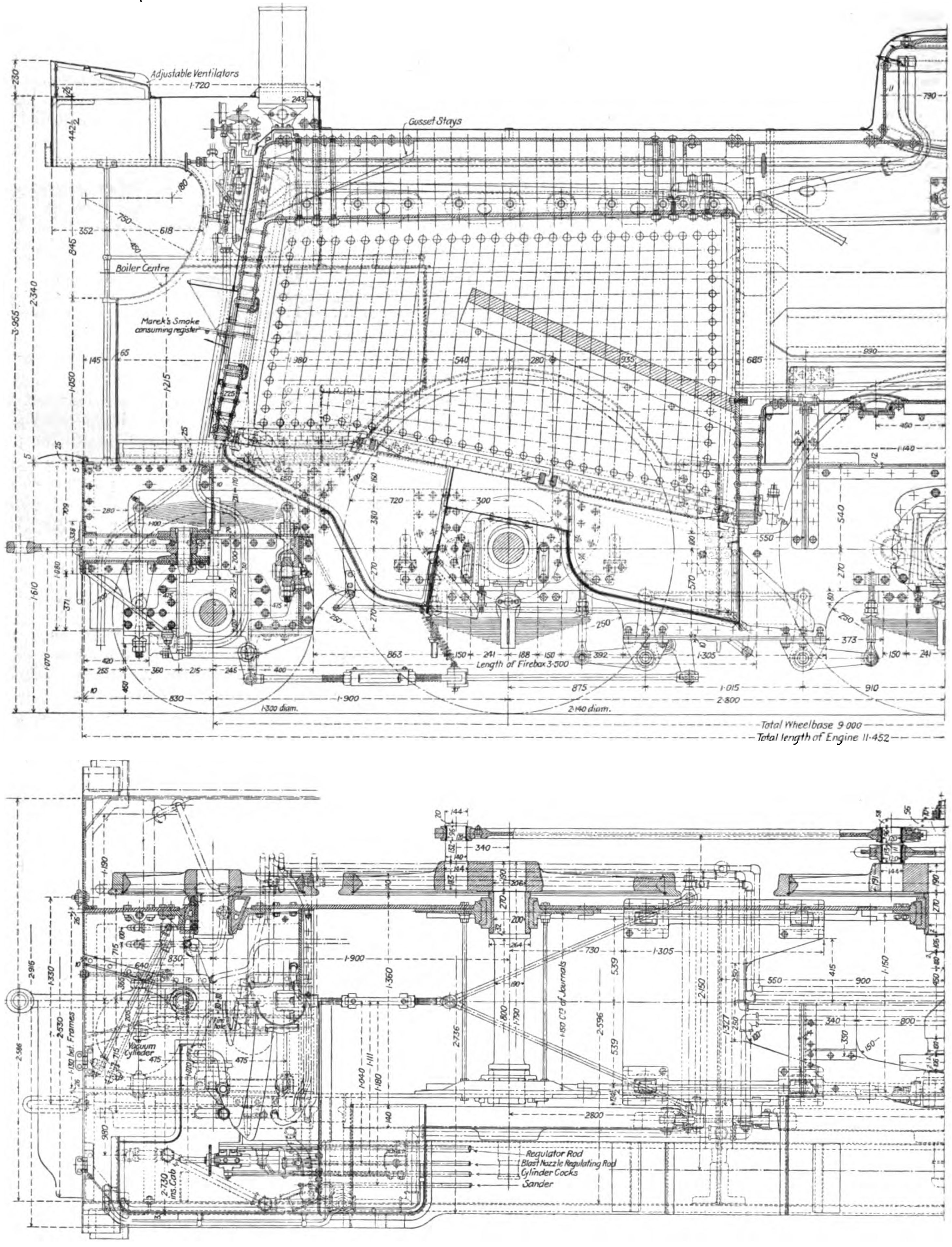
When a place is offered for inspection owing to an alteration in an existing line it has to be brought up-to-date so as to comply with all the requirements of the Board of Trade. This, unfortunately, often leads to expense, but the railway officials have the consolation of knowing that the signalling and accommodation is efficient.

At the inspection the officer will make notes of the matters requiring attention and will generally state verbally if he is satisfied. A few days afterwards the Board of Trade report will be received by the company. This will be a copy of that sent in by the inspecting officer.

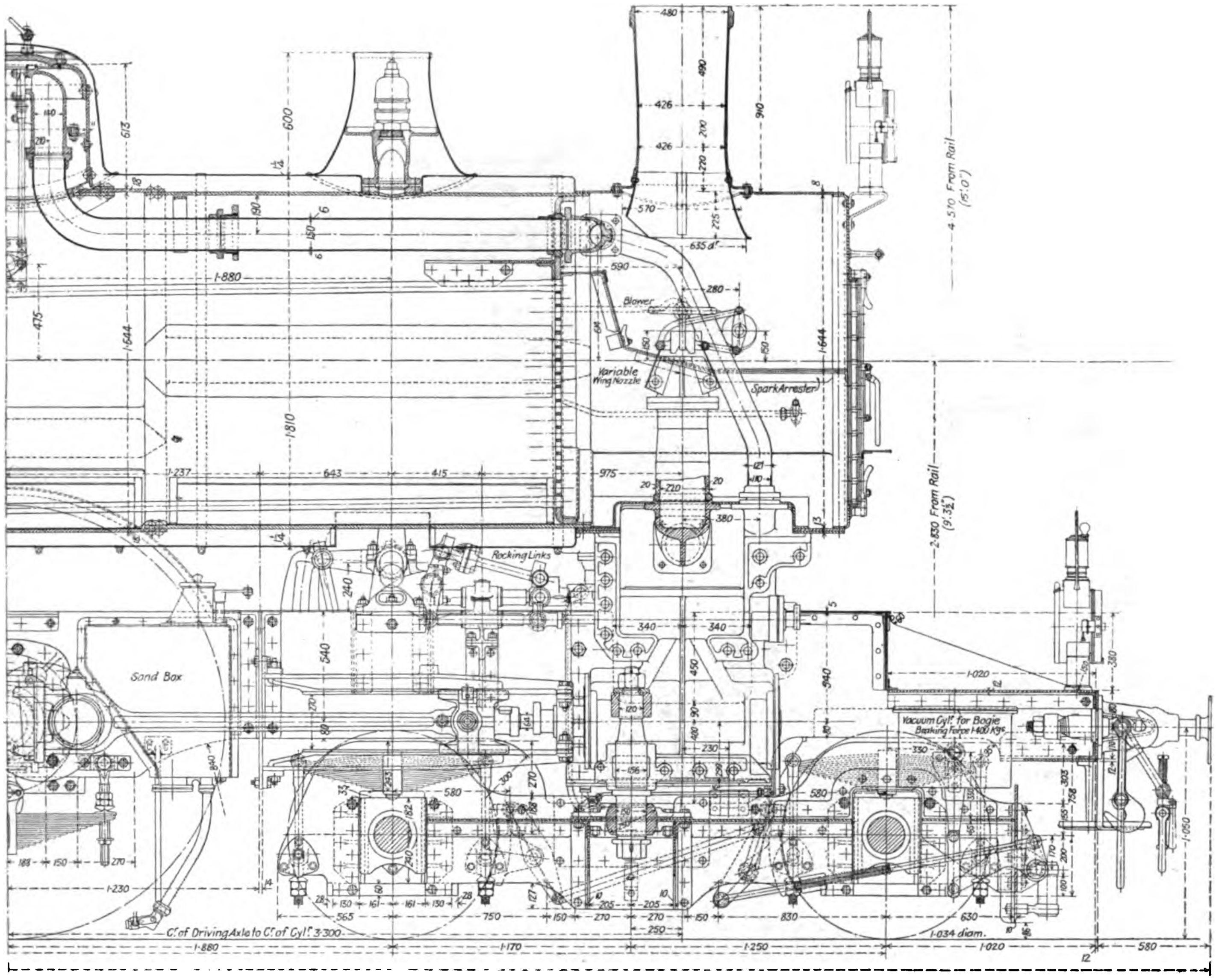
In the preamble, in the case of a new line, details will be given of the length of the line, the class of permanent way, rails, chairs, sleepers, fencing, etc.; what tunnels there are and their length; particulars of over-bridges and under-bridges, cattle creeps, culverts, etc., and their span; the various gradients and radii of the curves; the stations and the junctions. Then will follow details of the signal-boxes with the number of working and spare levers. At the conclusion of the report will be given details of the requirements in works, permanent way, and signalling.

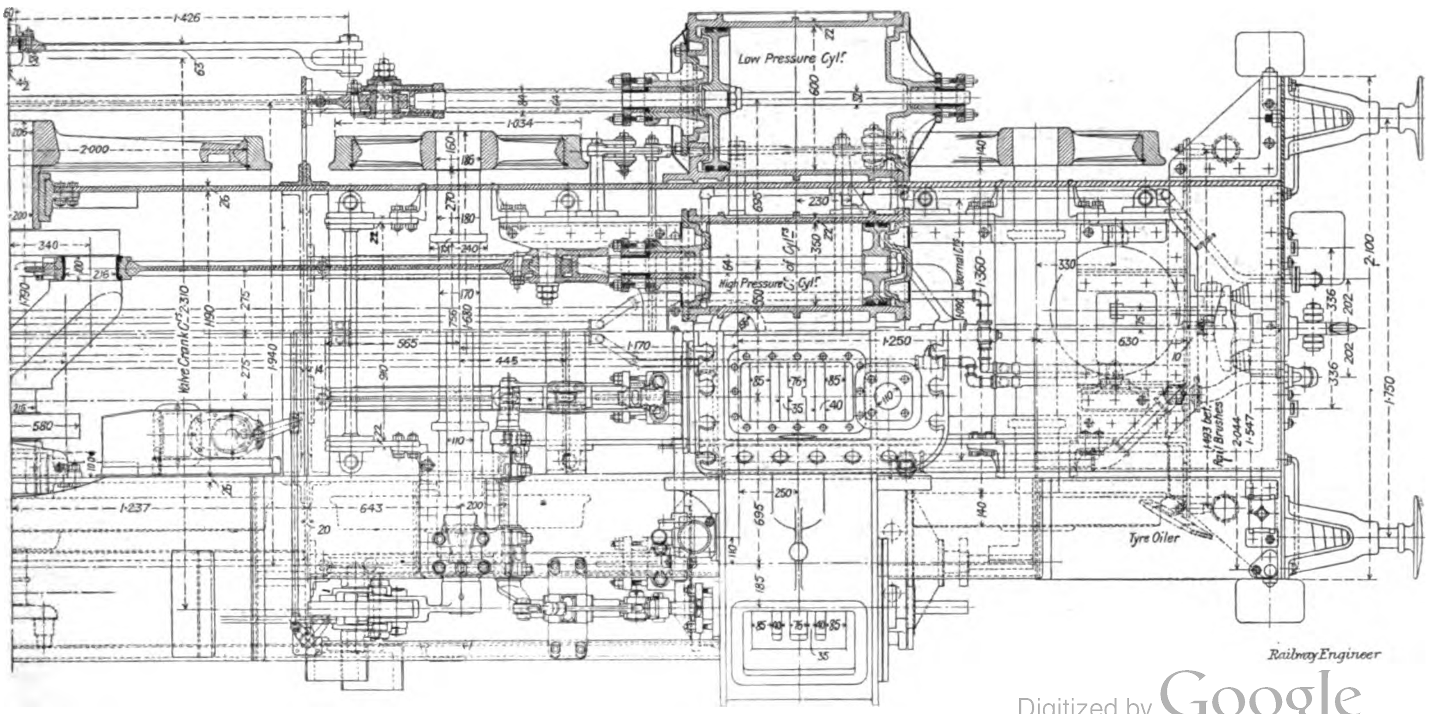
In the case of an alteration and not a new line the report is briefer and simply refers to "a new siding connection with the up line" or "the removal of a cross-over road at the east end of the station" or some similar simple description. Details will then be given of the signalling, as to the number of working and spare levers, and will conclude by saying either that the work is satisfactory or that certain requirements have to be carried out.

(To be continued.)

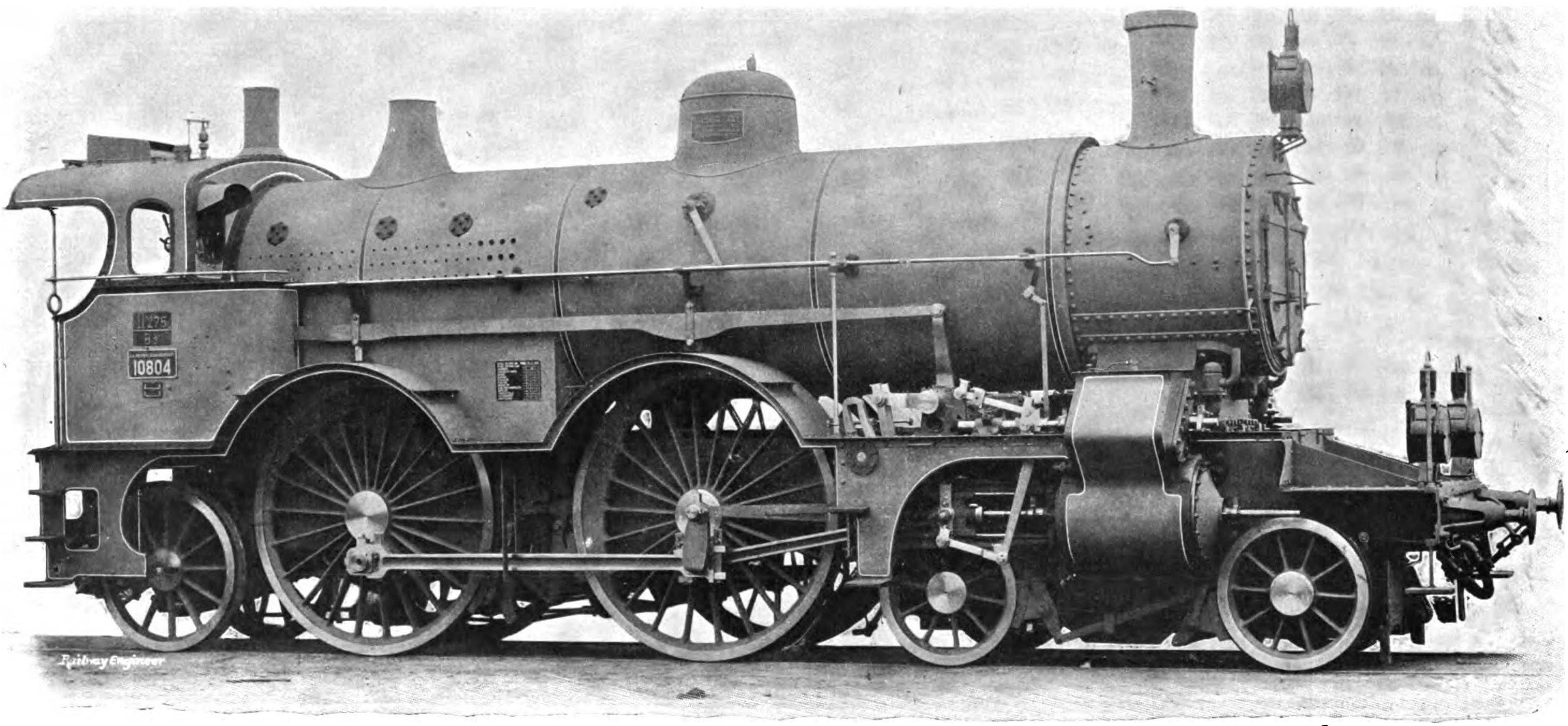


Four-Cylinder Compound Lignite-burning Express





Locomotives in Bohemia; Austrian State Railways.



Four-cylinder Compound Lignite-burning Express Locomotives in Bohemia; Austrian States Railways.

ABOVE and on the preceding and following pages we illustrate one of the large 4-cylinder compound engines which have been especially designed by Mr. Karl Gölsdorf to work upon the Bohemian sections of the Austrian State Railways.

The details of the design of these powerful engines are very interesting, because, owing to the lightness of the permanent way, it was imperative to reduce the weight so that the axle loads did not much exceed 14 tons, while at the same time these powerful engines had to be provided with a boiler of large capacity, constructed to work at a pressure of 220 lbs. per square inch, and capable of giving good results with a most inferior fuel, viz., a brown lignite of inferior quality.

These engines have been successful in every way. The cylinders, which are 350 *m/m* and 600 *m/m* diam. × 680 *m/m* stroke, are compounded upon the Gölsdorf system. The coupled wheels are 2,140 *m/m* diam. on the tread. The grate area is enormous.

In our next issue we shall publish some further drawings, together with a lengthy description of their construction and performance.

Front View of Four-Cylinder Compound Lignite-burning Express Locomotive; Austrian State Railways.

Board of Trade Regulations as to the Construction and Equipment of Tramways and Light Railways on Public Roads.

After two years' experience the Board of Trade has amended and extended the Memorandum, issued in January, 1903, regulating the details of construction and equipment of Tramways and Light Railways laid on public roads.

It will be noticed that the new Memorandum, which is printed in full below, is much more stringent than the old one was, and some of its provisions will, we think, excite a good deal of opposition and cause much trouble in certain districts, *e.g.*, the prohibition of covers to top deck cars on 3 ft. 6 ins. gauge lines will not be accepted quietly, and is, moreover, quite unnecessary. Several of the other requirements are of that grandmotherly order which is so dear to the heart of the Board of Trade. The Memorandum is as follows:—

Memorandum on Details of Construction and Equipment of Tramways and Light Railways laid on Public Roads.

January, 1905.

(1) *Clearance.*—The space between the inner rails of a double line must depend upon the overhang of the cars. It is, however, necessary that there should be at least 15 ins. between the sides of passing cars and also a similar space between the side of a car and any standing work such as lamp, telegraph and trolley wire posts in a street.

There should be at least 15 ins. between the side of a car and the kerb, whether on straight or curved roads.

The clearance between the top deck of cars and the underside of bridges should not be less than 6 ft. 6 ins.

(2) *Posts and Brackets.*—Centre posts should not be used without the consent, in every case, of the Board of Trade.

The stone kerbing round centre posts should not be such as to enable any person to stand upon it as a refuge, unless the clearance is ample for safety.

Where bracket arms 16 ft. in length will not suffice it is desirable that span wire construction should be used.

(3) *Permanent Way.*—The weight of rails should not be less than 90 lbs. per yard, 100 lbs. being preferred.

The groove of the rail should not exceed one and an eighth inch in width, but a groove not exceeding one and a quarter inch will be accepted on curves of less than one chain radius.

The details of permanent way and mode of construction as approved by the Board of Trade should not be varied at any time without the Board's consent.

(4) *Cars.*—Staircases of the "reversed" type should be avoided, more especially on narrow gauge lines.

Of existing types the "trigger" lifeguard is the pattern which is preferred. The hanging gate should be as close to the ground as possible, and there should be at least three feet between it and the front of the guard. Both the guard and the gate should be at least as wide as the outside of the frame of the truck.

In order not to interfere with the efficiency of the lifeguard it is desirable that folding steps should be adopted on all new cars.

The use of covers for the top deck of cars cannot be approved in cases where the gauge of lines is 3 ft. 6 ins. or less.

Top deck railings should be at least 3 ft. 6 ins. high.

The trolley standard must be connected with earth by a low resistance fuse or automatic switch, and the warning signal, when the fuse or switch opens, should be an electric bell.

Where trolley ropes cannot be dispensed with or tied up precautions must be taken to prevent the "slack" causing accidents.

To prevent trolley booms being pulled out or trolley standards broken "traps" should be minimised and detachable trolley heads provided.

No material alterations should be made in cars after inspection, nor any fresh type of car adopted, without the consent of the Board of Trade.

Young's Patent Valve-Gear and Rotary Valves for Locomotive Engines.

For nearly four years the Chicago and North Western R.R. Co. has been experimenting with a new valve gear invented by Mr. O. W. Young, which is illustrated by the annexed drawings, and which, according to our American contemporaries, has been brought to a high state of perfection.

The Chicago and North Western is one of the largest of the railway systems in the United States, being more than 7,000 mile

long and possessing over 1,300 locomotives. Its superintendent of motive power, Mr. Robert Quayle, may therefore be regarded as one of the leading authorities on locomotives in America, and hence his opinion upon the Young Gear and the results it gives in service are both valuable and interesting. They are as follows:—

"In June, 1901, the first engine was equipped, and, like all first attempts, there were certain details shown up which needed improvement. The general results with this engine justified a

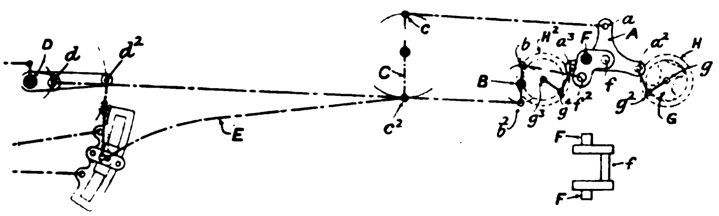


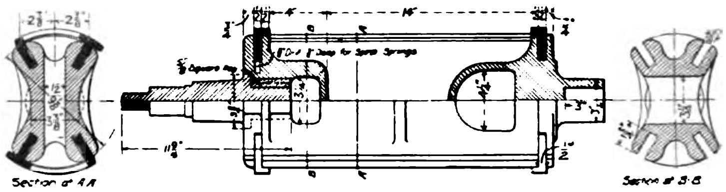
Fig. 1.

second trial, and in September, 1903, a set of cylinders with the special valves and their motion were applied to a 20 by 26 ins. Atlantic type (passenger) engine with 81 ins. over the tyres and 91,000 pounds on the drivers. The experiments with this engine lasted some six or eight weeks, and in November, 1903, the engine was put regularly into service on the Galena division. The engine has been a 'tramp' up to a very recent date; has had all kinds of service, all kinds of engineers handling her, and practically continuous service. It has so far made approximately 90,000 miles. The tyres have not been turned, the eccentric straps have been closed once about $\frac{1}{16}$ inch each; there is no pound in the boxes and the tool marks are still on the motion pins. These results are especially interesting to the motive records. In a series of comparisons made by the indicator the water rate per indicator horse-power was reduced from 22·9 to 19·3 pounds. The indicator cards also show the cause for the slight wear on the machinery, as they are remarkably full, the expansion lines being clear and distinct at all points of cut-off. Most of the work in passenger service is done at less than 6-inch cut-off.

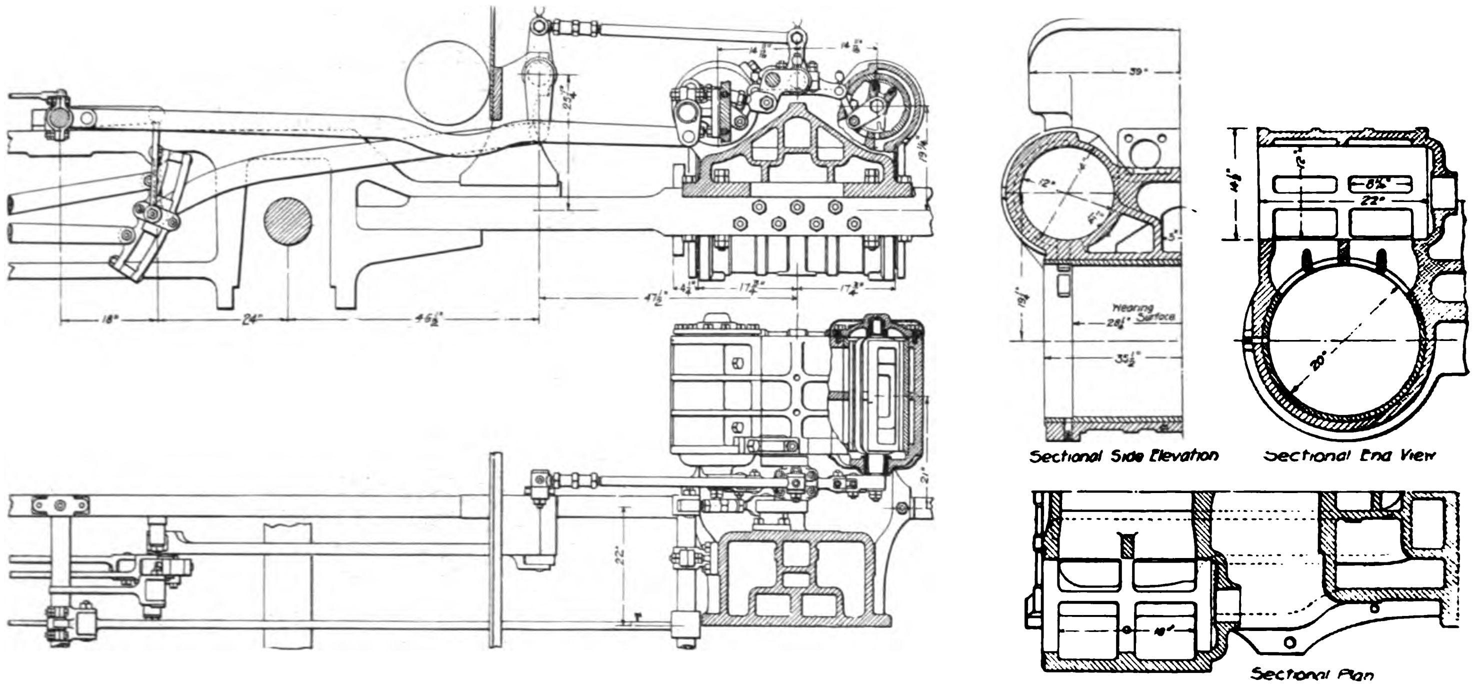
"The engine is one which will bear thorough investigation. While our experiments have been made in passenger service, I consider that the performance in freight service will show even better results from both operative and economical standpoints."

It will be noticed that the Young valves and gear bear a strong resemblance to the Corliss valves and gear. There are two rotary valves working in cylindrical bushes across the ends of the cylinders, and the gear by which they are operated will be readily understood from the diagram, fig. 1.

The ordinary link motion is connected by a connecting rod E to the rocking shaft C, the upper centre of which c is connected by the road ca to a "wrist plate" or ⊥ crank $aa^2\ a^3$ to the centres a^2 and a^3 of which are connected the links which work the valve cranks G.



Valve used with Young Gear.



Young Valve and Gear as applied to Atlantic Type Locomotives. Fig. 2. Cylinder arranged for Young Valve.

power official, demonstrating as they do that the wear and tear on the machinery is so remarkably less than that on the engines with the D or piston valves. The engine is always ready for service, the roundhouse foreman reporting that for his part of it five of this type would easily equal seven of the piston valve engines. There is one run between Chicago and Clinton, with usually ten heavy cars, on which this engine is the only one that can make the time.

"The train dispatchers know the value of the engine and they do not hesitate to rely on it to make up time or take an unusually heavy run. As a consequence the improvements shown by the indicator cards are not entirely realised in actual performance

The "wrist plate" is mounted on a crank, of which the fixed trunnions are F, a vertical arm Ff^2 of this crank is connected by an adjustable link f^2b to another rocker B, which is connected by a rod b^2d to a short lever d D on the reversing shaft D, so that as the ordinary link motion is notched up the centre f carrying the "wrist plate" is raised, and the admission lead of the rotary valves H is automatically decreased, while that of the exhaust is increased.

Many of the indicator diagrams taken on the engine with

this valve gear, and which have been published in the American papers, are most remarkable, and with the engine running at 29, 40, 49 and 55 miles an hour show no back pressure at all, and at 63 miles an hour only 2 lbs. But indicator cards taken on one trip, however interesting and however fairly selected, will not carry so much weight as Mr. Quayle's above-quoted general commendation of the gear.

Fig. 2 is reproduced from the *Railway and Engineering Review*. The patent rights are controlled by the Young-Mann-Averill Co., of Chicago, Ill., U.S.A.

Steam Motor Carriages—South-Eastern and Chatham Railway.

THE annexed illustration shows the Steam Motor Carriages which have just been built by Messrs. Kitson and Co., Leeds, and the Amalgamated Railway Carriage and Wagon Co., Ltd., Birmingham, to the designs of Mr. Harry S. Wainwright, M.Inst.C.E., chief mechanical engineer of the South-Eastern and Chatham R., and to whom we are indebted for the photograph and the following particulars.

It will be noticed that Mr. Wainwright has favoured what may be termed the detachable engine system with a 4-coupled engine provided with an ordinary small locomotive boiler.

The first of these cars is at work on the Sheppy line, but there are several lines or sections of the S.E. and C. system on which such vehicles could be used with markedly economical results.

The salient features of these steam cars are detailed below:—

The engine is on four wheels, and forms one of the bogies carrying the vehicle. The bogie centre pivot is fixed to a cross beam at the end of the carriage underframe. The wheel-base of engine bogie is 8 ft., and the wheels, which are coupled, 3 ft. 7 ins. diam. The cylinders, which are outside the frames, are 10 ins. diam. by 15 ins. stroke. The valve gear is of the Walschaert type.

The boiler is of the locomotive type, with a Belpaire fire-box. It has a total heating surface of 381 sq. ft., of which the tubes provide 337 sq. ft. The grate area is 8·8 sq. ft., and the working pressure 160 lbs. per sq. in.

The water tanks are placed at the sides, and between the bogie frames, and have a total capacity of 400 gallons.

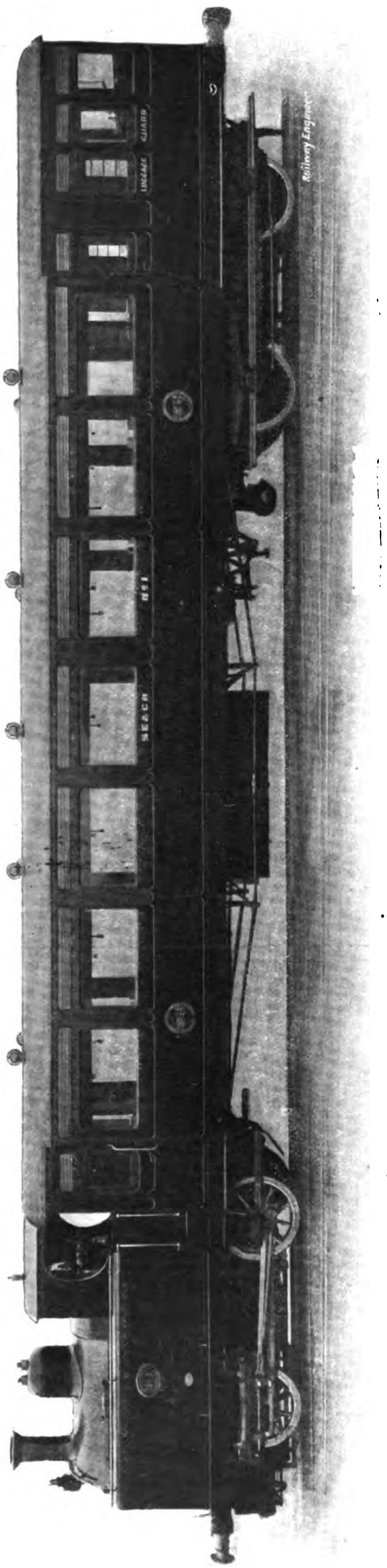
The coal bunkers are at the ends of side tanks, and carry about 15 cwts. The engine can be readily detached from the carriage, and run separately when in steam.

The total length over the buffers is 64 ft. $11\frac{1}{2}$ ins., and between the centres of the bogies 42 ft. The weight of the vehicle unloaded is about 38 tons, distributed as follows:—$24\frac{1}{2}$ tons on engine bogie and $13\frac{1}{2}$ tons on carriage bogie.

The steam motor carriage is capable of pulling a trailer weighing 16 tons at a speed of over 35 miles per hour on a level, or at an average speed, including gradients, of 30 miles per hour. It runs very smoothly, rubber pads having been largely employed to prevent vibration.

The engine coal consumption is extremely small, and economy in maintenance in several other directions will no doubt result of these vehicles.

The carriage body is 48 ft. 4 ins. long outside, and is divided into three compartments, viz.:—3rd class non-smoking, at the



Steam Motor Carriages : South-Eastern and Chatham Railway.

engine end, 19 ft. 10⅜ ins. long, 3rd class smoking 14 ft. 10⅞ ins. long, luggage and guard's compartment 6 ft. 8 ins. long. There are vestibules next to the engine and the luggage compartment.

Ordinary hinged doors, opening inwards, are provided in the sides of the body, and sliding doors are fitted between the guard's and passenger compartments, which are finished with teak.

The seats are arranged back to back, with a gangway down the centre. The seating accommodation provides for 32 non-smoking and 24 smoking passengers; ventilation is provided over each window and in the roof.

The entrance to the car is through the end vestibule, leading to the non-smoking and the smoking compartments respectively.

The underframe is constructed of steel. The carriage bogie wheelbase is 8 ft., the wheels being 3 ft. 6 ins. diam.

The cars are equipped with the vacuum-automatic and hand brakes, which are arranged to be operated from either end of the vehicle, as are also the regulator, reversing gear and whistle. Electric bells are provided for the guard to communicate with the driver. The cars are fitted with Stone's system of electric lighting.

Private Owners' 10-tons Tank Wagons.

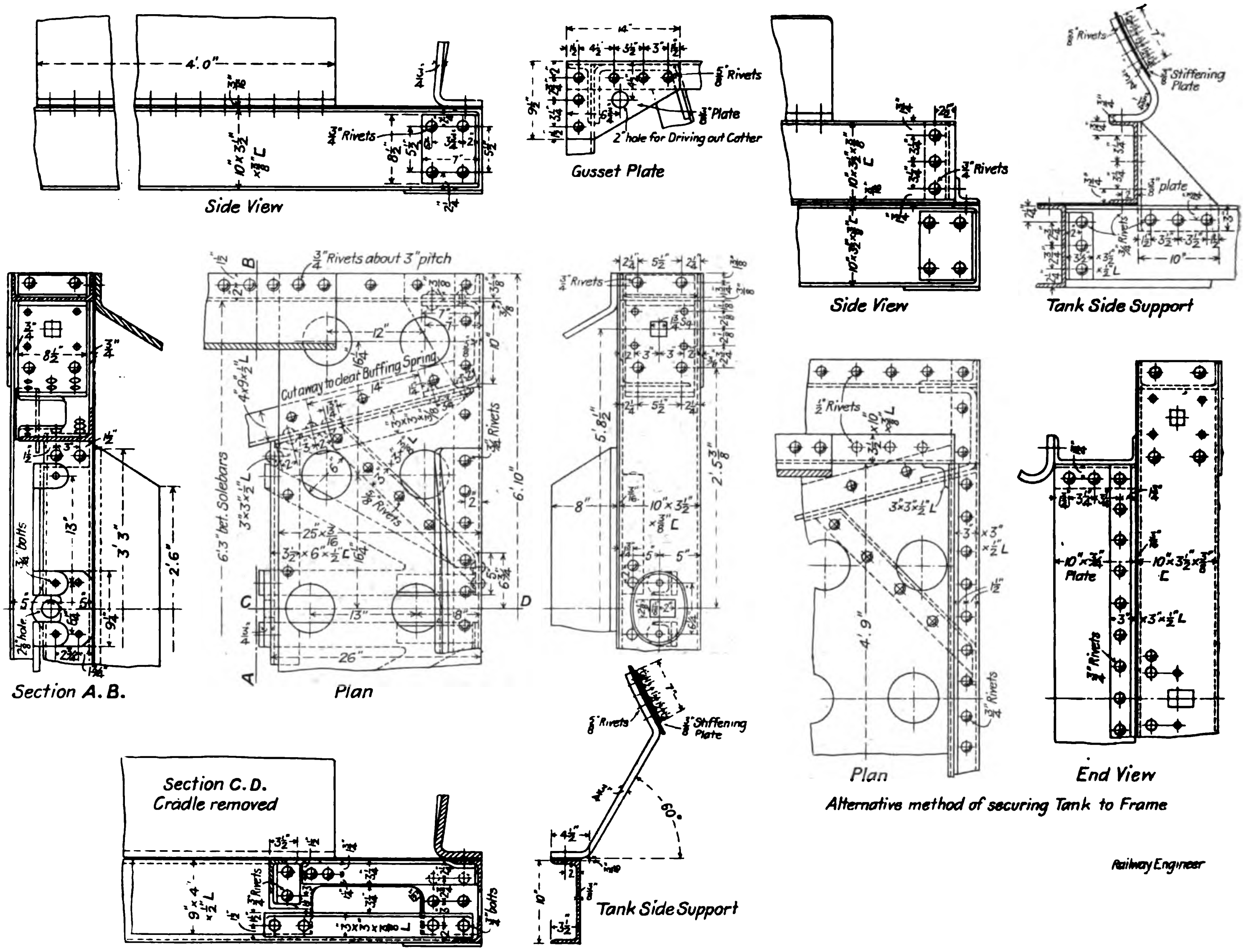
In our last issue, pp. 52-54, we published the standard specification (drawn up by the Clearing House Wagon Committee, of which Mr. James Holden, M.Inst.C.E., locomotive carriage and wagon superintendent of the Great Eastern R., is chairman, and to whom we are indebted for the drawings and specification), together with the general drawings which accompany it, of the private owners' 10-tons tank wagons, and we now publish detail drawings of the frame and the tank supports; the manhole and its cover; the loading bar and valve; the tank fastening and the cast iron spring shoe.

As regards the other details we have not given the drawings because we have already done so, as noted below:—

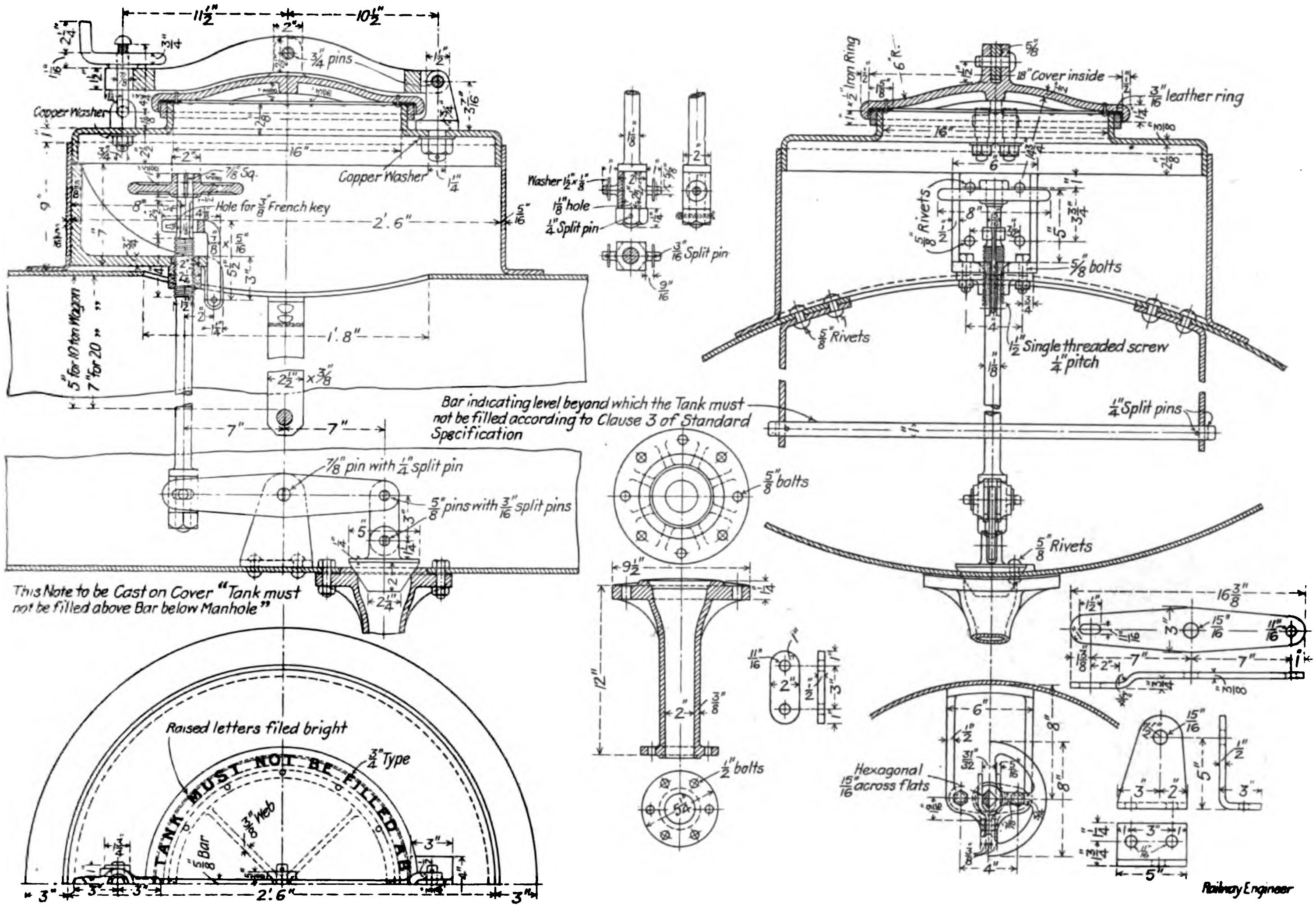
The drawbar hooks and couplings, drawbar plate and drawbar cradle (except the length, which is 2ft. 6ins. inside) are the same as for all the other private owners' wagons.

The intermediate drawbar is the same as that of the 10 and 12-tons private owners' wagons (see *Railway Engineer*, February, 1904).

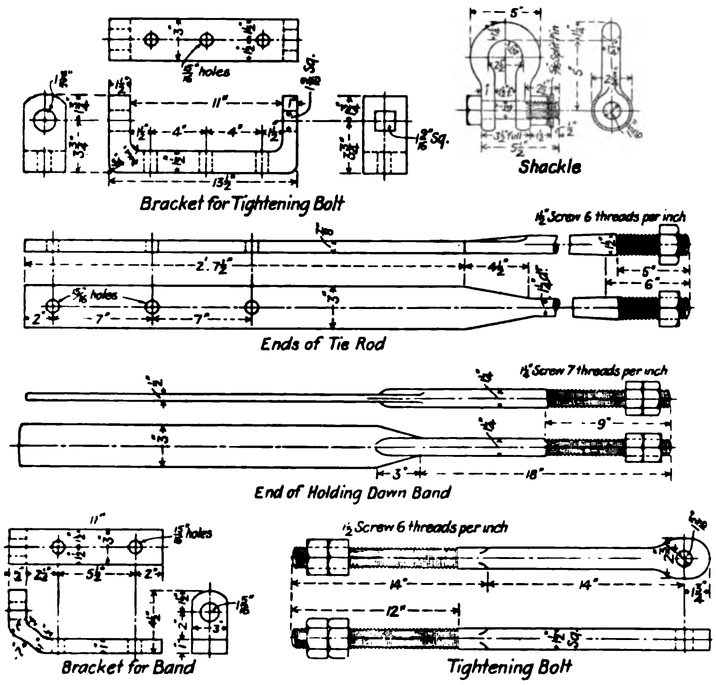
The wheels, tyres, axles, axle-boxes are the same as those of the 12 and 15-tons private owners' wagons (see *Railway Engineer*, December, 1904).



Frame Details and Tank Supports. Private Owners' 10-Tons Tank Wagons.

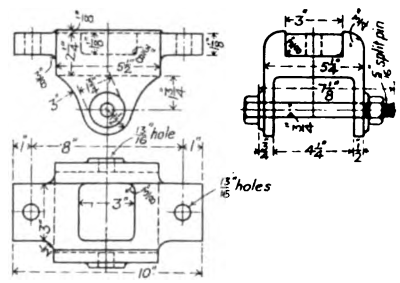


Manhole, Cover, Loading Bar and Valve Details. Private Owners' 10-Tons Tank Wagons



Tank Fastening Details. Private Owners' 10-Tons Tank Wagons.

The buffing guides and buffing spring shoe, axle-guard and stay, and buffing spring cradle (except as total length, which is 2ft. 3⅛ins.) are the same as for the 20-tons private owners' wagons (see *Railway Engineer*, October, 1903).



Cast Iron Spring Shoes.

The buffer (except diameter, which is 13ins.) and buffing spring are the same as for the 10 and 12-tons private owners' wagons.

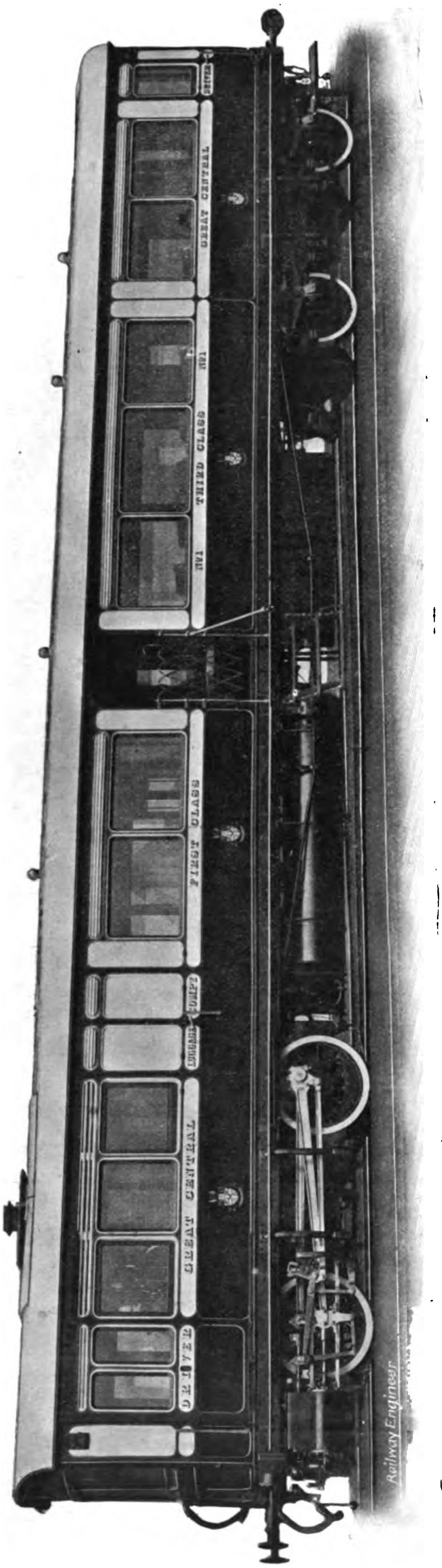
The bearing springs with 8 plates (except as to the camber, which is 5¼ins.), and those with 5 plates, are the same as those for the 10 and 12-tons private owners' wagons.

The pressed steel spring shoe is same as for the 10 and 12-tons private owners' wagons.

The horse hooks (except as to the holes, which are 13/16 in. diameter, and the flanges, which are ⅜ in. thick instead of ½ in.) are the same as for the 15-tons private owners' wagons.

Steam Motor Cars: Great Central Railway.

In our issue for last October we published a drawing and full description of the Steam Motor Cars which Mr. J. G. Robinson, M.Inst.C.E., chief mechanical engineer of the Great Central R., has designed and built at Gorton for his company. These



Steam Motor Car; Great Central Railway.

cars are 61ft. 6ins. long over the body, and are constructed to seat 12 first and 44 third-class passengers. They are equipped with vacuum automatic and hand brakes, electric light, electric bells (for the guard to signal to the driver), and steam heating apparatus. And they can of course be completely controlled from either end.

It will be seen from our illustration, which has been produced from a photograph kindly placed at our disposal by Mr. Robinson, that these cars have a particularly handsome appearance and that they have outside cylinders, coupled wheels, and the Walschaert valve gear. The entrance is arranged at about the middle of the car and is provided with hinged steps so that passengers may be picked up at places where there are not platforms as well as at stations. When not required the steps fall under the body.

These cars are intended to provide more frequent services between towns and in outlying districts, but they are also capable of long journeys, for one of them recently travelled from Gorton to Marylebone and back.

Recent Patents relating to Railways.

THESE abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d.* each.

Automatic Block Signalling. *19,996, 16th September, 1903. A. Oesterreicher, 21 Penzingerstrasse, Vienna XIII., and Lorenz Nemelka, 33a Rennweg, Vienna III.*

In this system of block-signalling, an electric block-switch or instrument, figs. 3, 4, 5, which is operated by the automatic interruption of an electric current, is controlled by connections made by the train by means of a single contact wire or conductor or of a single rail-contact, and this block-switch or instrument, after receiving a series of current-impulses, makes such electric connections that, on the one hand the corresponding signal is brought to the "stop" or "line blocked" position, and on the other hand, after this signal has been in the "stop" position, the block-switch or instrument of the signal in the rear begins to act and switches the motor actuating the signal into the "line clear" position. In the above system the signals can either be brought positively into both positions or they can be made as gravity signals. Figs. 1 and 2 are diagrams of an electric block system for a two-track line, with signals which can be set positively in both direc-

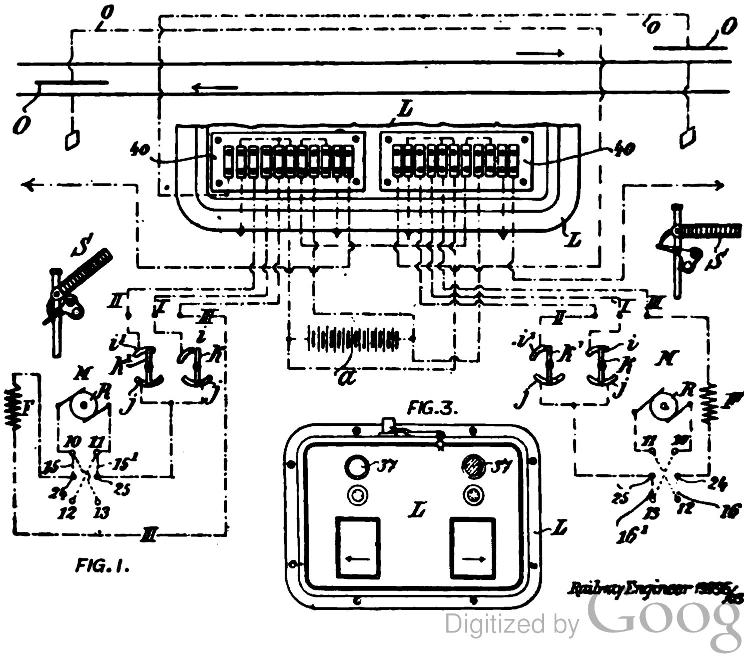


FIG. 1.

FIG. 3.

tions, and fig. 14 shows the connections of a single track provided with gravity signals. The blocking and freeing of the sections is effected by the train through a conductor *o* and contact rail O. The signal motors M set the signals S in both directions, and also actuate the electric switches, one of which is a double or reversing switch with the contacts 10, 11, 12 and 13, while the other forms a circuit breaker with two brushes k, k^1, and arc-shaped contacts i, i^1, j. The storage battery *a* is connected to the block switch L by means of the wires I., II., and the common return III. with the motor

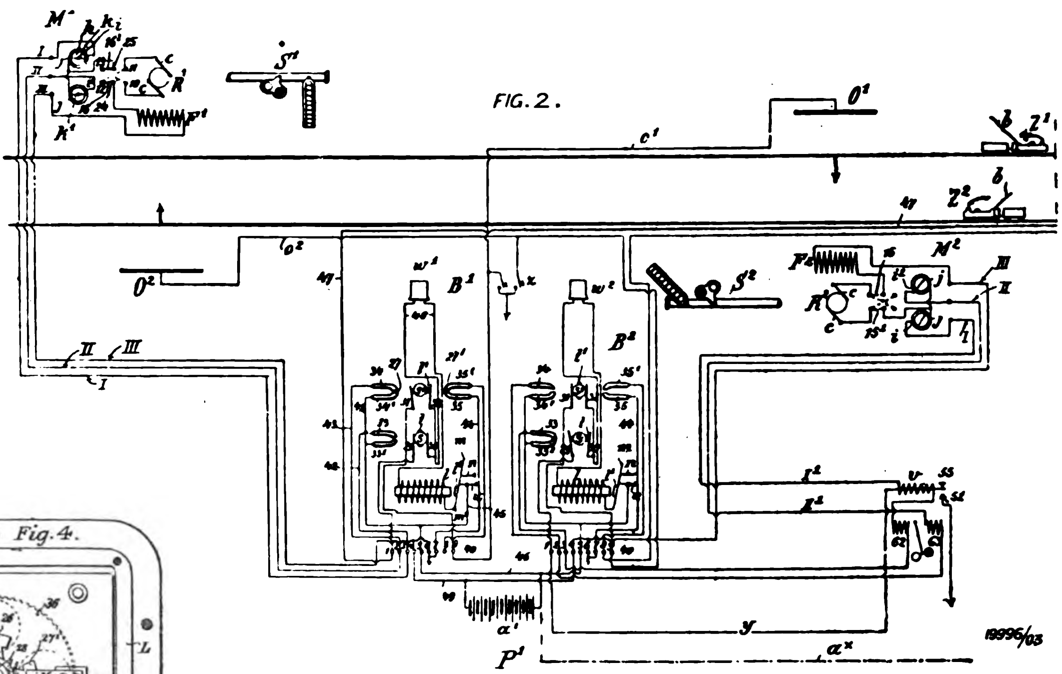


FIG. 2.

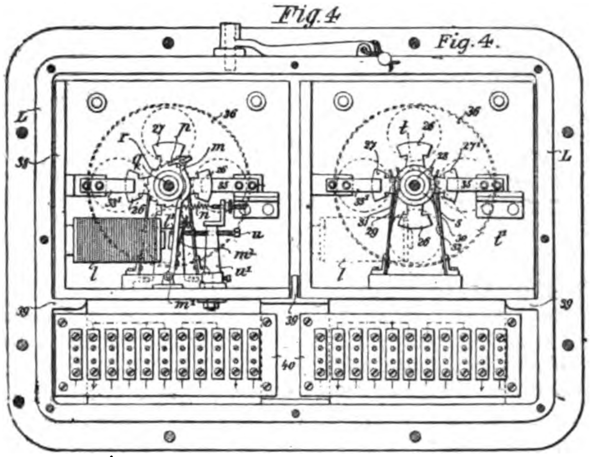


Fig. 4.

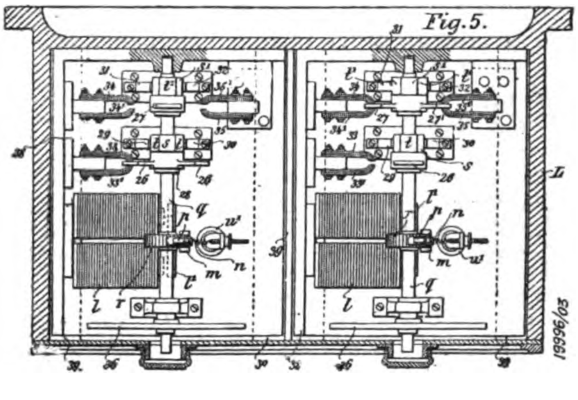


Fig. 5.

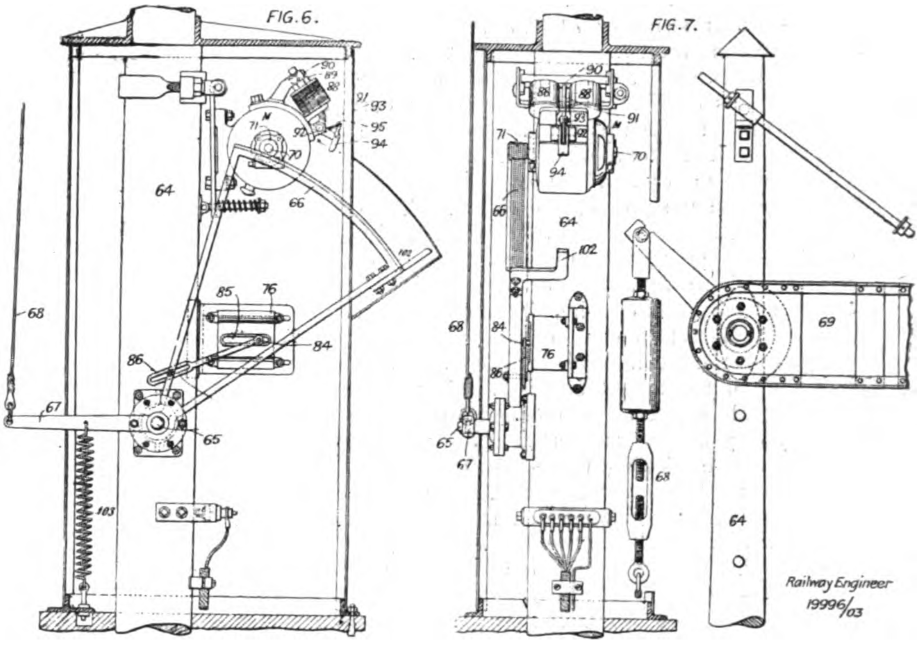


FIG. 6. FIG. 7.

M. If the signal has to be brought to line clear the current passes by the conductor I., while the conductor II. is interrupted, but if it is brought back to line blocked the current passes by the conductor II. To prevent the motors from passing beyond the end positions the operating-rods are provided with dash pots, or the motors are stopped by short-circuiting brakes. The block-switch L comprises the electro-magnet *l*, the armature lever *m* of which is provided with the spring contact m^2, the contact blades 26, 27, 27^1 insulated from the spindle *q* but mounted thereon, the brass rings *s*, s^1, fig. 2, with their insulating fingers *t*, t^1, the spring contacts 29, 30, 31, 32, and the contact strips 33, 33^1, 34, 34^1, 35, 35^1. When the blade 26 makes contact with the

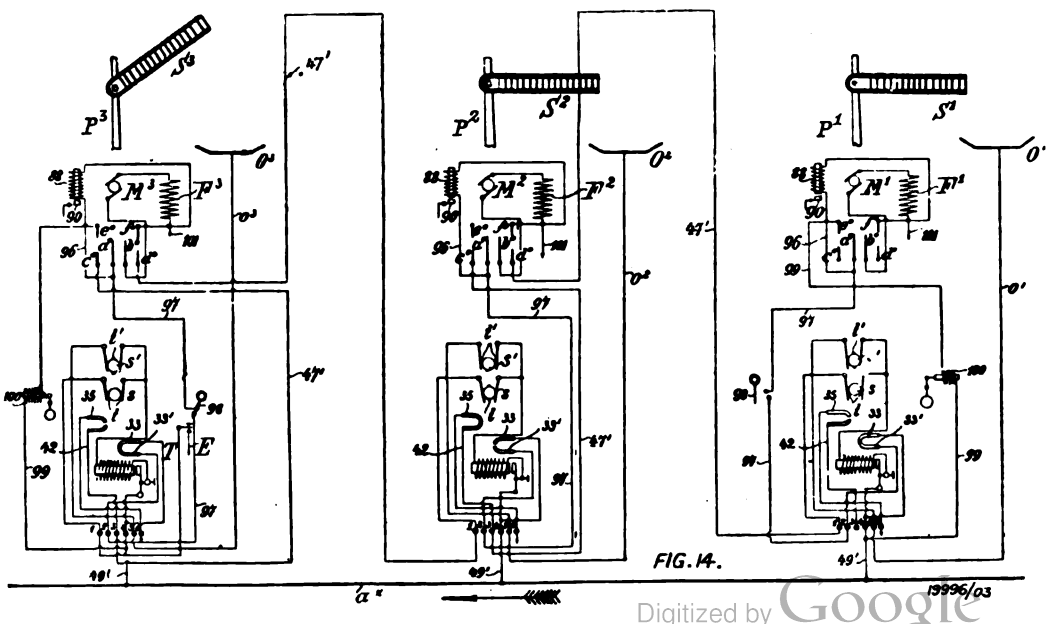
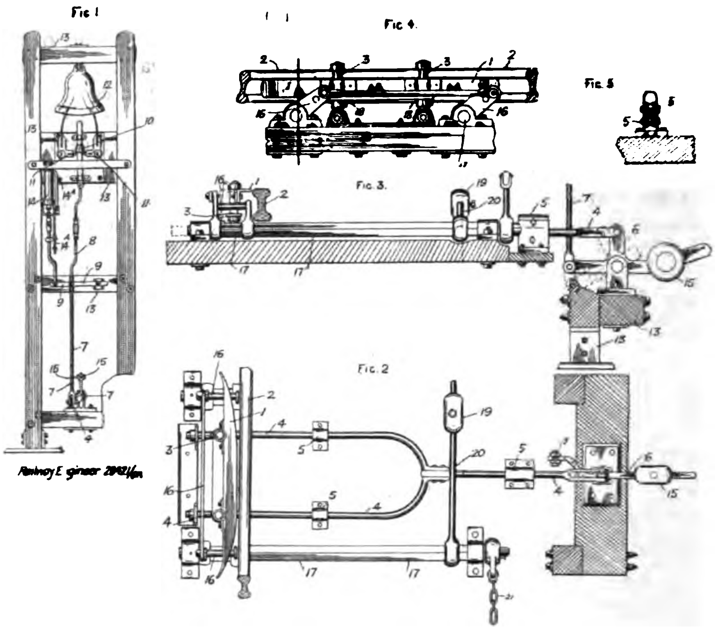


FIG. 14.

strips 33, 33^1, the spring contacts 29, 30 rest against the fingers *t*, while the blades 27, 27^1 are out of contact with the strips 34, 34^1, 35, 35^1. When the blade 26 makes contact with the strips 33, 33^1 the corresponding spring contacts 29, 30 rest against the corresponding insulating fingers *t*, while the blades 27, 27^1 are out of contact with the strips 34, 34^1 and 35, 35^1 and the spring contacts 31, 32 rest against the corresponding brass rings s^1 and *vice versa* (see fig. 5). Owing to the circuit breaking device in the block-switch a single attraction of the armature l^1 does not effect the switching in or out of the contact blades 26, 27, 27^1. If storage batteries are not provided for each signal station, current is derived from the feeder wire a^x. The apparatus *v* connected through conductors I^1, II^1 to the corresponding wires I, II consists of a manually-operated switch 55 and a visual indicator device 62, 63 of known construction which is arranged beneath and indicates the position of the distance signal. An additional double key *z* is connected to the wire *o* to take over the function of the train. When gravity signals are employed the motor M on the post moves a segment 66 which turns about a shaft and is connected to the signal arm by a rope or rod 68. The switch which controls the motor is mounted below the motor, and interrupts the current as soon as the signal arm reaches the line clear position. The switch plate consists of the strips a^0, b^0, c^0, d^0, e^0, f^0, above which are contact-pins mounted in a common bridge piece, movable to and fro in the direction of the strips. In one end position of the bridge piece the four strips a^0, b^0, c^0, d^0 are connected together, in the middle position the two long strips a^0, b^0, and in the other end position the two short strips e^0, f^0 are connected together. The contact strips a^0, b^0 interrupt the motor current at the proper time, while the strips c^0, d^0 effect the inter-connection of the block system with the rear section, and the strips e^0, f^0 effect the operation of the optical controlling apparatus 100 indicating the position of the signal. The catch device which holds the segmental piece in the line blocked position consists of two electro-magnets with a movable armature connected to a bell-crank provided with a pawl capable of yielding in one direction. A hand switch *t* and clearing switch 98 are provided. The clearing of a block-section can be controlled by contacts, which are arranged on the mechanical interlocking apparatus of the track, or on the point-setting mechanism. In multiple arm signals the main signal segment is coupled to a piece actuating the auxiliary signal by means of a pawl device controlled by a separate electro-magnet, so that in bringing the main signal into the line clear position, if the pawl-device is acting as a coupling by reason of current being supplied thereto, the auxiliary signal is also brought into the line clear position, while when the current is interrupted in the corresponding electro-magnets the signal arms automatically return to the line blocked position. (*Accepted 26th November, 1903.*)

Signalling Apparatus (Automatic). *28,421. 28th December, 1903. J. Ledbrook, 25, Golden Hillock Road, Small Heath; E. E. Lewis, 7, Palace Road, Small Heath; and T. Hawkins, 49, Bristol Road, Edgbaston, Birmingham.*

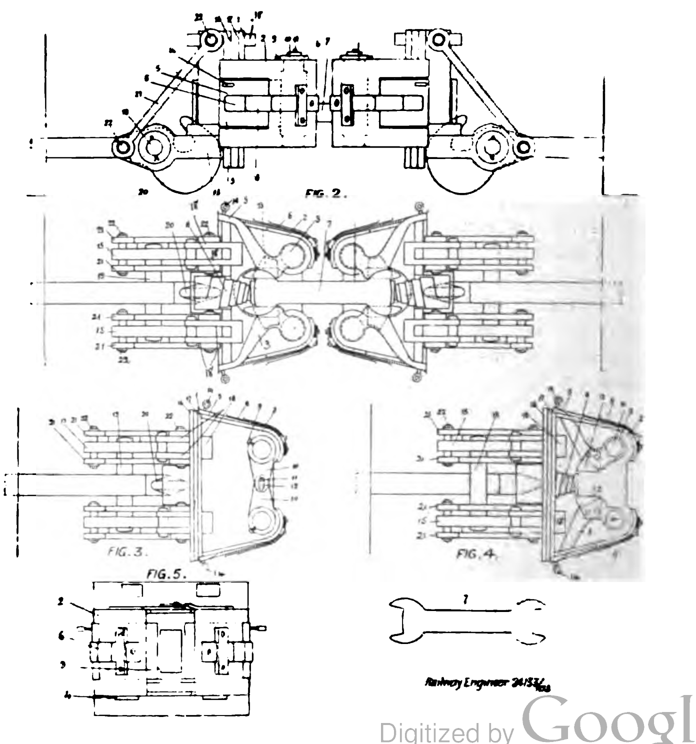
A contact bar or block 1 is mounted by the side of the rail 2, to slide vertically upon forks 3 mounted upon or forming part of a horizontal rod 4 sliding in roller bearings 5. The horizontal rod is connected by means of a lever 6 to a vertical rod 7, which is in turn connected to a second vertical rod 8 through the medium of a pivoted lever 9. The rod 8 carries a stud or cam 10 which actuates the tail end of a hammer 11, so that the hammer when moved by the stud or cam 10 strikes a bell gong or discs 12 hung at a suitable height from a frame work 13. A vacuum or pneumatic chamber 14 and counterweight 15 are mounted on the apparatus to regulate the time before the striking mechanism can come into operation after having been once acutated. A suitable rocking arrangement 16 is provided, upon which the contact bar 1 slides in a horizontal direction away from the rail when moved by the flange on the wheel of a locomotive. When the contact bar 1 is moved by the flange on the wheel of a locomotive it slides upon the rockers 16 away from the rail 2, as shown by dotted lines in fig. 3, thus drawing out the horizontal rod 4 to which it is connected, the horizontal rod 4 through the medium of the levers 6 and 9 and vertical rod 7 drawing down the vertical rod 8, which actuates the hammers 11 for striking the bell gong or discs 12. The apparatus may also be connected to the ordinary signalling apparatus by means of a chain or wire 21,



attached to the rod 17, upon which the rockers 16 are mounted, so that the rockers may be turned down at an angle as shown by fig. 4, allowing the sliding block 1 to slide downwards upon the forks 3 of the horizontal rod, and rest upon a seating 18, provided lower down the forks, thus allowing the block 1 to be thrown into its actuating position when either semaphore signals are at danger. Or the rockers may, if so desired, be actuated independently of the signals. (*Accepted 22nd December, 1904.*)

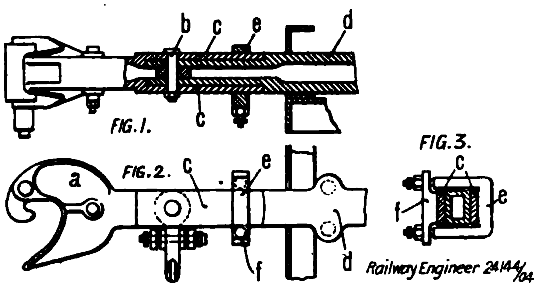
Couplings (Automatic). *24,133. 6th November, 1903. E. Benedetti, 24, Via Napoli, Rome, Italy.*

A casing composed of a drawplate 1 and side walls 2 has two jaws 3 pivoted on its forward end at 4 and provided with tail-pieces 5 which project through lateral openings in the casing, where they are acted upon by springs 6, which tend to press the jaws inwards. A bar coupling 7 of rectangular or square cross-section, with both its ends provided with heads rounded off at the sides and recessed at their outer ends, but of the same height



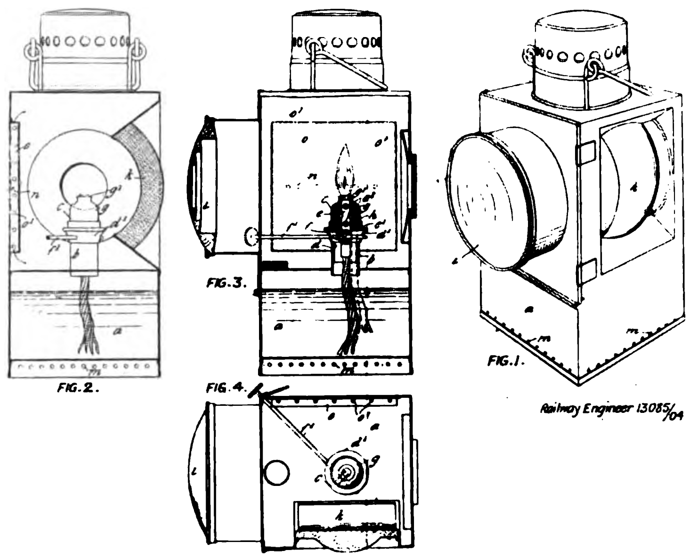
or thickness as the bar, enters with one of its ends into the box until it comes in contact with a strong spring 8 mounted on the draw plate 1, and remains in contact with it by the action of the springs 6, causing the jaws 3 to engage behind the head of the coupling bar. In order to facilitate simultaneous movement of the two movable jaws 3 there is secured to the upper end of the shaft 4 of each arm, by means of a key 9, an inwardly directed lever or crank 10, their inner ends overlapping in the centre, one of them carrying a pin 11 sliding in a groove or slot 12 in the other. By means of this arrangement movement communicated to one of the jaws 3 is immediately transmitted to the other. In order better to support the coupling bar 7 between the jaws 3, two supports 13 of any suitable shape could be added, as shown in fig. 4. Two rings 14 on the tails 5 of the jaws 3 serve to operate them to uncouple. Two angle plates 15 are applied to the draw plate 1, stiffened by two other plates 16 and 17 by means of tie-bars 18, and are connected by a cross-bar 19 forming part of the draw hook 20 of the existing coupling attached to the vehicle. In order to resist and to oppose entirely any other strains, four ties 21 connect the ends of the plates 15, four cross-bars 22 connecting the ties 21 to the plates 15. Should it be desired to use the ordinary coupling hooks 20, the frame and its parts can be turned up bodily about the bar 19 as a pivot. (*Accepted 6th December, 1904.*)

Couplings (Automatic). *24,144. 1st February, 1904. Fried Krupp Aktiengesellschaft, Essen, Germany.*
Relates to means for securing the automatic coupling head to the draw-bar or stem in such manner that it can be steadily swung aside when the ordinary screw coupling is employed. The head *a* is rotatably mounted on the bolt *b* and in such manner that its



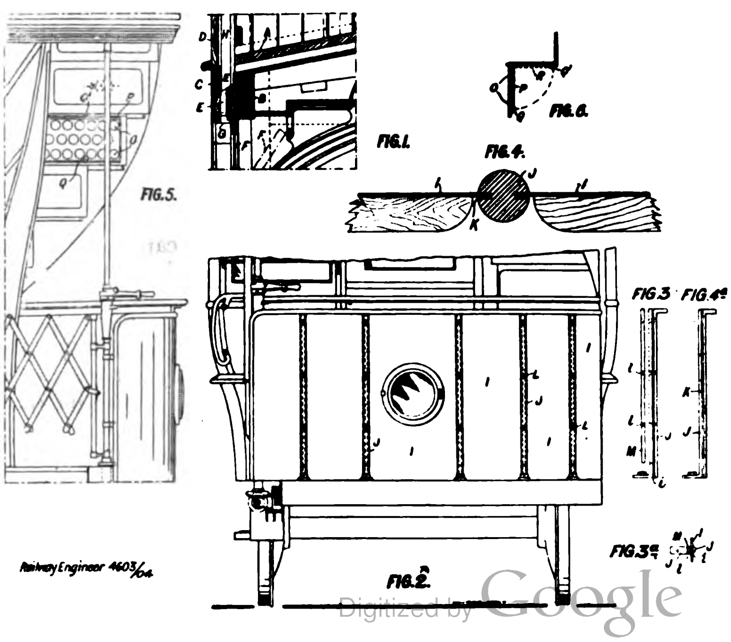
lateral lugs *c* embrace the stem *d* of the coupling on two diametrically opposite sides. Over the rear end of the lugs *c* is passed a U-shaped clamp *e*, over the screw threaded free ends of which is pushed a bridge piece *f*, which when the automatic coupling is in use can be drawn tightly against the lugs *c* by means of nuts. By this means the lugs *c* of the rocking head *a* can be tightly pressed against the stem *d* of the coupling. When using the draw hook provided for ordinary couplings, the nuts of the clamp *e* are slightly loosened and the clamp pushed towards the head piece. The head of the coupling can then be swung round and the clamp again pushed forward. (*Accepted 8th December, 1904.*)

Signal Lamps. *13,085. 9th June, 1904. W. H. I. Welch, 33, Lichfield Road, Bow.*
The upper part of the burner tube *d* terminates in a cup d^1 through which projects the upper part of the wick tube, which is formed with a number of perforations e^2. A cap *g*, the upper end of which terminates in a suitably shaped burner piece g^1, is screwed on the cup d^1, and in the space between the cup and the wick tube is coiled a length of cotton wick or other suitable absorbent material *h*. This material may be extended downwardly to the oil tank *a* through a hole in the cup d^1 as shown in dotted lines in fig. 3, in which case the oil supply to the reservoir constituted by the coiled wick *h* is independent of the burner wick. By means of the auxiliary reservoir of absorbent material oil is drawn either from the main oil tank, or from a low level of the burner wick, to a higher level of the burner wick at or near the point of combustion. When the wick *h* does not itself extend downwards to the oil tank, it is saturated with oil by the burner wick which is in communication with the storage wick *h* through the holes e^2 in the burner tube. A concentrating lens or condenser *i* is arranged in front of the lantern with its axis in line with the flame, and similar lenses may be provided in the back or sides of the lantern. When the lamp is intended also to illuminate a lateral signal such as a semaphore arm or the distinctive signal of a distant signal lantern such as described in the Specification to Patent No. 15,343 of 1898, it is provided at one side with a lens adapted to concentrate and direct the light in a vertical plane and form a sector beam, which illuminates the semaphore or the distinctive signal of the lantern. The preferred form of lens is shown in the drawing, and consists essentially of a segment of a substantially



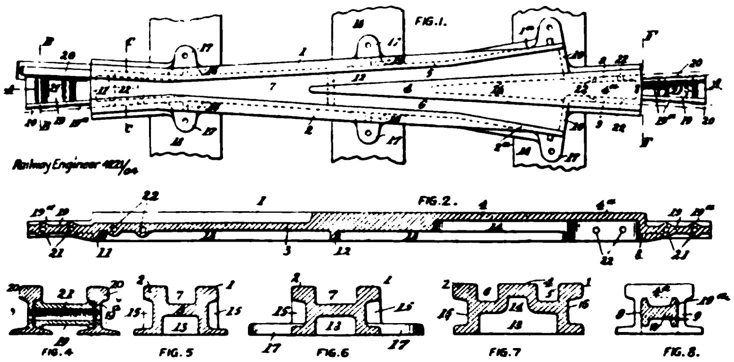
cylindrical shell *k*, the axis of which is horizontal, and the curvatures of which give the required focussing effect. In the arrangement shown the inner face of the lens is cylindrical and the outer face has a transverse circular curvature of suitable radius. The air required for combustion passes through holes *n* in one or more of the side walls into a chamber such as *o* inside the lamp, whence it is allowed to issue through, and is distributed around the flame by means of holes o^1 in the edges or sides of the chamber, thereby preventing any draught or direct impingement of the air on the flame, and thus enabling a smaller flame to be employed (*Accepted 22nd December, 1904.*)

Tramcars. *4,603. 24th February, 1904. E. A. Stanley and J. E. Anger, of Electric Railway and Tramway Carriage Works, Strand Road, Preston*
The drainage of the roof or top deck A, of the car, is improved and the lowering of the sashes of the roof cover, where such is employed, is facilitated by formin along each side of the car between the outer face of the upper ongitudinal rail B of the car



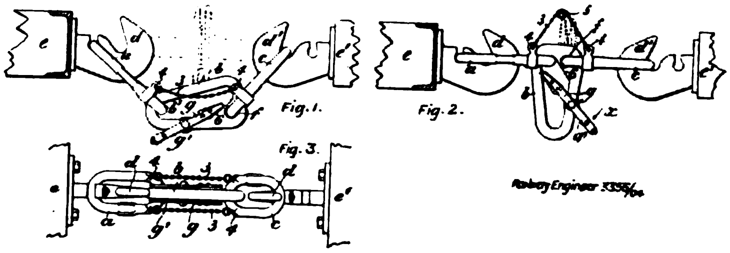
body, and an outside board C that is preferably flush with the advertisement board D, an interspace or interspaces E, which form vertical passages to lead off any water that may fall on the roof or top deck A of the car. The longitudinal rails B lie immediately above the ordinary inlet ventilators F or side openings and the passages E therefore have their outlets G immediately above and on the outside of the ventilators F. The flooring boards of the top deck A are stopped short of the outside boards C and advertisement boards D, and thus clear passages are left through which water falling on to the top deck A will drain away. This arrangement is specially suitable for cars with top deck covers, because the vertical passages E are made so as to be practically a continuation of the cavities or ways H down which the window sashes of the roof cover slide, and thus it is possible to slide down the sashes much lower than is customary, in fact their bottom edges can be slid below the top deck A without interfering in any way with the drainage. That part of the interspaces E where the sashes slide is preferably made wider than the sashes so as to leave a free passage for water drainage to run down, and thus whether the sashes are down or whether they are raised, water will flow down these interspaces E and drain away to the outside of the car at G. The passages E also form air ducts by which fresh cool air is admitted. These drainage passages are placed at intervals along the entire length of the car. The dash plate of the car is built up in segments I so that if one of the plates be broken or bent the damaged part can be readily replaced. In the stairs a perforated riser is provided for the driver to look through, and provided with a hinged door P which can be shut down to close the perforations, or folded up flat against the underside of the step above. (*Accepted 31st December, 1904.*)

Crossings. *4,221. 19th February, 1904. R. A. Hadfield, Parkhead House, Sheffield.*
The crossing, which is cast in one piece of manganese steel, comprises two side portions 1 and 2 that are connected together throughout their length and between their upper and lower surfaces by an intermediate horizontal portion 3, which, for a part of its length and for a part of its width, is extended upward to form the wedge shaped point or tongue portion 4. The gradually diverging wedge shaped portion 4 of the crossing is extended longitudinally beyond the horizontal portion 3, as shown at 4^a, and each extension is combined with a downwardly extending transverse end piece 8 and also with vertical side portions 9, which, in cross section, are made of a shape corresponding to



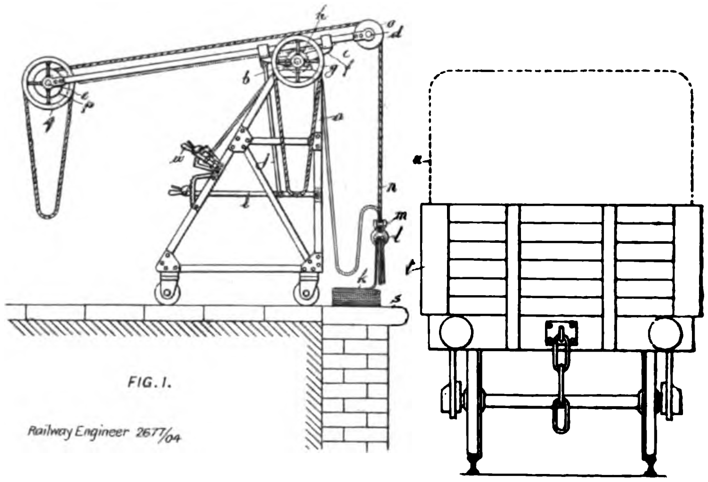
that of the stock rails to be used with the crossing, and are connected by vertical laterally inclined portions 10 to the side portions 1 and 2. Strengthening ribs, 11, 12, 16, are formed on the lower portion and on the sides of the crossing, whilst each end is formed with an extension 19, to which the stock rails 20 are secured. As will be seen from the several sectional views no part of the crossing is of great thickness or mass in the shortest direction, not more than about two or three inches as a maximum, and the greater portion of the crossing is of nearly uniform thickness, so that the whole casting is specially adapted to withstand the heat treatment to which it is finally subjected, such heat treatment consisting in slowly heating the casting one or more times to a suitable toughening temperature and subsequently cooling it, as by immersion in water. Furthermore, by the construction described, the crossing is rendered light and also elastic or yielding under loads travelling over it. (*Accepted 22nd December, 1904.*)

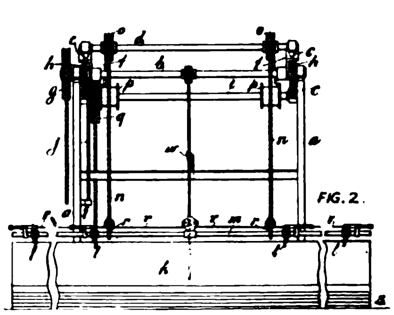
Couplings. *3,355, 10th February, 1904. A. G. Spencer, 77, Cannon Street, London.*
This invention has reference to coupling chains with a triangular tightening link interposed between the end links, and its object is to enable the tightening to be readily effected. For this purpose the adjacent ends of the inner and outer links of the chain are connected together by flexible connectors such as chains, so arranged that either of them can be readily engaged by the end of a pole, such as a shunting pole, held by a person at either side of the vehicle, and lifted, so that assuming the coupling chain to



have been connected to the draw-hooks of two adjacent vehicles, and to be hanging in a slack or loose condition in which the intermediate link is suspended with its longest sides extending in a more or less longitudinal direction, the inner ends of the inner and outer links will be simultaneously raised and moved nearer together and the intermediate link caused or allowed to turn upon one of the links and fall into a position in which its short side will be uppermost, and in which it will hold the adjacent ends of the inner and outer links near together, and so shorten the coupling chain and effect a tight coupling of the vehicles. With a view of reducing liability of the outer link becoming accidentally detached from the draw-hook, by shock caused by the outer end of the inner link striking against the opposite inner surface of the intermediate link, the surface is suitably inclined. (*Accepted 15th December, 1904.*)

Wagon Coverings. *2,677. 3rd February, 1904. H. Hartley, Clarence Chambers, Corporation Street, and V. Canova, 55, Gopsall Street, Birmingham.*

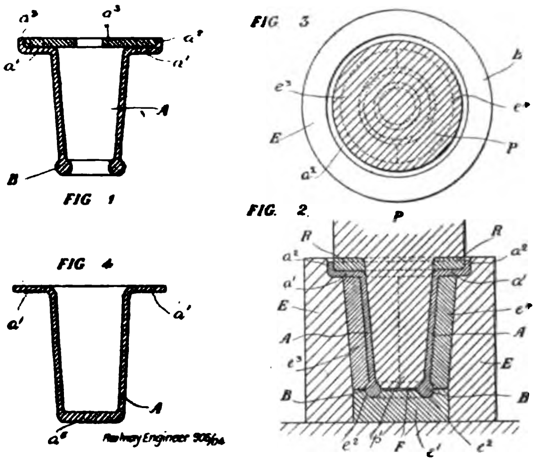




This invention provides a mechanical appliance for spreading cover sheets over loaded wagons, which comprises a portable

standard or framing *a* and a jib *c* provided with lifting tackle. The jib can be inclined to suit the height of the load by operating a lever *i*, and can be transversed horizontally in respect to the standard by cords and drums, or as shown by racks and pinions *h*. The lifting tackle, by means of which the sheets *k* are raised and spread, consists of a number of grips or clips *l* attached to a horizontal bar *m*, with lifting chains or ropes *n*, which pass over suitable guide pulleys *o* mounted upon the cross shaft *d* at the front end of the jib, and are anchored or secured upon the winding drums *p* on the cross shaft *e* at the other or rear end. The shaft *e* is provided with a suitable hand rope or other operating or lifting wheel *q*. The connection between the ropes *n* and the horizontal or lifting bar *m* is effected through the medium of shackles as *r*, or in other convenient manner. Suitable means are provided for releasing the grips when the sheet has been spread. (*Accepted 8th, December, 1904.*)

Buffers. *906. 13th January, 1904. A. Cashmore, 100 Lyttleton Street, West Bromwich, Stafford.*
This invention relates to the production of buffer cylinders from sheet steel blanks. A blank having a sufficient thickness and mass to produce a cylinder of the desired size is punched out while hot, then reheated in a usual gas or other furnace and treated



in a press, where it is placed over a die, whilst a plunger descends and forces it into the shape of a collar or truncated cone, and this process may require several re-heatings and treatment in more than one pair of tools. The cylinder is then finished by pressing in a final press to produce the necesary flange on the large end, or it may after re-heating be treated in a rolling mill such as is used for rolling tyres, for finishing and flanging the cylinder. (*Accepted 8th December, 1904.*)

SPECIFICATIONS PUBLISHED.

A.D. 1903.

18980. Electrical signalling or railways and tramways; Tunstall. 24133. Car couplings; Benedetti. 25908. Apparatus for grinding rails of tramways and the like whilst in position; Bennett and Moorwood. 26962. Emergency hook or coupling hook for railway vehicles; Friederici (Stepan). 27493. Apparatus for operating points and signals on railways and tramways; Walker and Bidder. 27614. Rolling or re-rolling of rails; Lentz and Tozer. 28053. Detonating and luminous signals; Senthe. 28077. Couplings (automatic); Wait. 28269. Fog signalling apparatus; Bailey. 28421. Audible signalling apparatus; Ledbrook, Lewis and Hawkins.

A.D. 1904.

220. Composite rail ties or sleepers; Bowman. 717. Fog-signalling apparatus; De Senan. 906. Buffer cylinders; Cashmore. 1388. Fluid pressure brakes; Westinghouse Brake Co., Ltd. (Westinghouse Air Brake Co.). 1703. Fire-boxes for locomotive boilers; Kemmerich. 2182. Appliance for cleaning tramway and like rails; Fawdon. 2544. Joint for train rails, &c.; Firth. 2587. Seats for railway vehicles; Lake (Budd). 2599. Means for securing axles to corves, tubs, wagons, &c.; Blackburn. 2677. Covering goods wagons or trucks; Hartley and Canova. 2768. Joints, and the construction and setting of tramway and other rails; Shepherd. 2845. Railway vehicles; Ames. 2961. Apparatus for the simultaneous locking and unlocking of carriage doors; Munro. 3261. Valves for fluid pressure brakes; British Thompson-Houston Co., Ltd. (General Electric Co.). 3355. Couplings; Spencer. 3384. Safety guard for carriage doors; Singleton and Rushton. 4089. Connecting chairs to sleepers; Holden. 4131. Tramway brakes; Betteley. 4221. Crossings; Hadfield. 4274. Safety devices for tram cars; Echte and Purdie. 4307. Operating tramway points; Bousfield (Chesi). 4603. Tramcars and other vehicles; Stanley and Anger. 4676. Insulators for the conductors of electric railways; Bradford, Ward and Furniss. 5017. Frogs or crossings; Kimball and Conners. 5070. Fluid pressure brakes; Orloff. 6929. Safety devices for tramcars; Nuttall and Pearson. 11323. Label holder for wagons; Bower. 11923. Seats for railway vehicles; Budd. 12016. Repairing worn rail heads at the abutting ends of rails. Melaun. 13085. Signal lamps or lanterns; Welch. 13149. Couplings; Roche. 15343. Electric railways and tramways with overhead conductors; Anderson and Dunne. 17120. Point and switch mechanism; Thurston. 17535. Supporting and fixing tramway rails; Pollard. 18988. Safety apparatus for tramcars; Stanley and Anger. 19234. Rail joint and electric rail bond; Webber. 20679. Brakes; Marx and Kroschwitz. 21456. Detonator apparatus; Burris and Kerr. 22057. Rail joint and means for securing rails to sleepers; Lingard. 22178. Rail joints; Wheatley (Minor). 22199. Ash cup for railway compartments; Sponneck. 23999. Drilling cramp for rails; Kemmish. 24144. Couplings (automatic); Fried Krupp Akt.-Ges. 24722. Electric tramcars and safety devices therefor; Whittaker. 24759. Couplings (automatic); Fried Krupp Akt.-Ges. 24886. Rail joints; Cloud. 25187. Pavements and permanent way substructures; Von Prunkl. 25363. Tramways and the like; Kenway. 25724. Rail chairs; Annis and Devore. 25870. Nut locks; Wise, Cooper and Miller. 26046. Couplings; Lecompte.

Official Reports on Recent Accidents.

Near **Downton Station, L. & S.W.R.,** *on the 2nd November. Major J. W. Pringle, R.E., reports that:—*

Owing to the breaking of a coupling a portion of the 4.50 p.m. up goods train from Wimborne was left behind on the single line at the south end of Downton Station and was run into by the 7.58 p.m. down passenger train from Salisbury. Two passengers complained of injury.

Downton Station is on the single branch line from Salisbury to Wimborne, which is worked on the electric tablet system. A train approaches from the south on a rising gradient of 1 in 78, and from the north on a falling gradient of 1 in 100. The actual length of level through the yard between these gradients is about 187 yards. The available length of loop for passing trains is about 130 yards.

The goods train arrived at Downton Station 25 minutes behind time, and it was necessary to detain it to allow an up and a down passenger train to pass through the station, and which were due at 7.51 p.m. and 8.17 p.m. respectively.

The goods train, consisting of an engine with 31 vehicles, was about 225 yards long, whilst the available length of loop line in the station is only about 130 yards, and there is no siding into which the train could have been shunted. It was therefore first drawn outside the loop on to the single line north of the station, so as to allow the up passenger train to run into the loop, and then backed through the down loop on to the single line at the south end of the station.

This was done about 7.50 p.m., and after the up passenger train had left the goods train was kept in its position on the single line, outside the up home signal, until the down passenger train arrived at 8.19 p.m. The whole of the goods train was during this interval standing on a gradient of 1 in 78, the engine at the higher end.

The down train arrived, and Signalman Summers was then able to obtain a tablet for the goods train to proceed over the single line to Alderbury Junction. He lowered the up home signal and the goods train started and entered the up loop line.

As the train moved away the coupling between the 16th and 17th vehicles parted, and the rear 13 waggons and 2 brake vans were left behind on the single line. These 15 vehicles then commenced to run back down the incline; but after running about 50 yards they were checked and brought to a standstill by brakesman Ingram, who applied his hand brake.

Summers, as the goods engine passed, handed the tablet to the fireman from the six-foot way in front of the signal-box. He did not wait to see the tail lights of the goods train pass him before returning to the box. He accordingly lowered the down starting signal for the passenger train, which had attained a speed of 20 miles an hour when his engine struck the standing waggons. He did not see the side light on the rear brake van, and was not aware of the waggons having been left behind, or of any obstruction in front of him, until the collision took place.

Driver Dart and fireman King, enginemen of the goods train, and guard Wisdom, who travelled in the leading brake van behind the engine, were also unaware that half of their train had been left behind, until they had run about 100 yards beyond the signal-box. Wisdom then showed a red light,

and Dart stopped the train. The train must by that time have travelled at least 300 yards from where it started.

A coupling line broken at the end and with a bad flaw was found, and it probably was the one which directly caused the accident.

The collision would not have occurred if signalman Summers, as was his duty, had taken the proper steps to assure himself that the whole of the goods train had passed him before allowing the passenger train to proceed.

It is difficult to excuse guard Wisdom and driver Dart for not discovering at an earlier moment that they had left half the train behind them. Under Rule 171 (*f*) the driver must, "when the train has started, see that his fireman exchanges hand signals with the guard in rear, so as to be sure that the whole of the train is with them." Where there is a front and rear guard, as in the case of this goods train, it was manifestly the duty of the front guard to exchange signals with the rear guard, and in the case of the non-receipt of an "all right" signal it should have occurred to both front guard and engine driver that something was wrong long before the train had travelled so far as it did. It was not the non-receipt of the hand signal which caused Wisdom to show a red light, but the speed attained after getting into the loop, which drew attention to the lightness of the train. The night was dark, but quite clear.

The length of the loop being only 130 yards the signalman had to adopt the clumsy method of working which has been described.

But in view of the steep gradients at either end of the yard the method of working adopted involves, as this case proves, danger from couplings breaking. To obviate this danger some action is desirable, such as the lengthening of the loop, so that it shall be capable of containing full length goods trains, or the construction of a refuge siding into which such trains can be shunted when required. It is hoped that the Co. will be able to see their way to carrying out the necessary works.

*

At **Snow Hill Station, S.E. & C.R.,** *on the 9th November. Major J. W. Pringle, R.E., reports that:—*

The 7.16 p.m. (Loughborough Junction to Moorgate Street) had just started, when a following train, the Midland Co. 7.2 p.m. (Victoria to Kentish Town), struck it. The rear guard of the first train was severely bruised, and complaints of shock were received from two passengers in the Midland train.

The collision occurred on the down, or western, road at the south end of Snow Hill Station; the railway from Ludgate Hill to Snow Hill having a general direction from south to north. The two signal boxes concerned, viz., Ludgate Hill North box and Snow Hill box, are both at the north extremity of the respective station platforms and on the west of both lines of way. The distance between the two boxes is about 475 yards. For a length of 214 yards the railway is in tunnel. After passing Ludgate Hill North box a train on the down line travels on the level for a distance of 75 yards. Thence there is a very sharp falling gradient through Snow Hill Station with an inclination of 1 in 39.

The traffic between the two stations is worked on Sykes' lock and block system, by which the Ludgate Hill North down advance starting signal cannot normally be operated for a second train until a treadle in advance of the Snow Hill down starting signals has been actuated by the previous down train, and until it has been electrically released by the signalman in Snow Hill box working the plunger on his down line lock and block instrument.

In addition to the usual instruments, there is in Ludgate Hill North box a special bell, which is actuated by a separate electric circuit, the completion of which is only made by the drop of the indicator of the Sykes ordinary instrument from "Locked" to "Free." This bell continues to ring until its circuit is broken by the replacing of the down advance signal to danger after the signal has been lowered.

The lock and block instruments are maintained by Sykes and Co., whilst all the wires in connection with them are maintained by the railway company.

Signalman Dunk, of Ludgate Hill North box, explained that the first of the two trains concerned left Ludgate Hill Station at 7.33 p.m., under normal conditions. Shortly afterwards, when the train had actuated the treadle in advance, he replaced his down advance signal to danger behind the train. The second train arrived at Ludgate Hill at 7.35 p.m., and Dunk permitted it to start at 7.36 p.m., by lowering the down starting signal. His intention at the moment was to hold the second train at the down advance signal. He did not offer this train on the bell instrument to Snow Hill, as he had not received the clearance bell signal from Snow Hill for the first train. As the train was running out of the station the chatterer bell began to ring. This bell commences ringing at the same moment as the release of the down advance signal is made, and continues ringing until the signal lever is worked and replaced. Forgetting that no bell signals had been exchanged with Snow Hill regarding the second train the sound of this bell led Dunk instinctively to lay hold of the down advance signal lever and pull it over. The lever answered his pull and came over in the frame in the ordinary way, as if it had been properly released, and the signal was thereby lowered for the second train.

Driver Buckett, of the Midland train, states that he saw the down advance signal was "off" before passing Ludgate Hill North box, and steamed past it. He found the down distant signals at danger and travelled through the tunnel at a low rate of speed with steam shut off and brakes applied. He could not see the down home signals for Snow Hill until he was abreast of them. These signals are in the tunnel in the six-foot way, 12 yards from the south end of the station platforms, and were all at danger. He immediately applied his brakes fully, but was unable to avoid a collision owing to the proximity of the train in front of him.

The collision was brought about by the admission of the second train into the block section between Ludgate Hill North down advance signals and Snow Hill down starting signals when that section was occupied by the first train. This breach of block working was occasioned either by irregularities on the part of one or both of the signalmen concerned, or by a failure of the lock and block signalling apparatus. The evidence points to the latter of these two alternatives.

The casting which forms the vertical slide to the lock holding the down advance signal lever was broken. The lock might thus have dropped out of the vertical, in which case the lever would be free to move, when the indicator on the instrument showed that it should be "locked."

But the breaking of this casting would not have caused the chatterer bell to ring, or have lowered the indicator of the Sykes instrument from "Locked" to "Free."

The evidence proves that a fault, amounting to nearly a full "earth," was found on the 11th November on the Sykes down line circuit in the tunnel between the two stations. Other wire circuits in the same cable were discovered to be "earthing." Although there is no evidence to prove actual contact and short circuiting from other wires, there is the evidence of lineman Mussared to the effect that on the 10th November, when he was fitting the new locking in Ludgate Hill North box, the indicator on the Sykes down line instrument dropped on two occasions from "Locked" to "Free," and the chatterer bell must consequently have rung without any apparent cause. In view of this statement, and of the faulty condition of the circuits, it is not unreasonable to conclude that the same occurrence may have taken place on the night of 9th November, as described by signalman Dunk.

It is difficult to say whether the breakage of the casting might have been prevented by more careful examination or more frequent renewals, but the fault on the Sykes instrument wire could undoubtedly have been discovered and remedied before it had attained any serious dimensions. The case points to the necessity for more careful inspection and examination, and more frequent testing of all details in connection with the system of working in use than at present obtains.

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The Railway Engineer

Volume XXVI., No. 303. *April*, 1905.

Contents for April.

Mr. Alfred Baldwin, of Stourport, ironmaster, M.P. for the Bewdley Division of Worcestershire, and a director of the Great Western R., has been elected chairman in succession to **Earl Cawdor**, who has retired from the Board on his appointment as First Lord of the Admiralty in succession to the Earl of Selborne, who has been appointed to succeed Lord Milner in South Africa. Mr. Baldwin was elected a director of the Great Western R. in 1901. He is chairman of Baldwins, Ltd., one of the largest iron and steel "combines" in the country, and also of the Metropolitan Bank of England and Wales.

The Rt. Hon. Walter H. Long, M.P., has also resigned his seat at the Board of the Great Western R. on his appointment, with a seat in the Cabinet, as Chief Secretary for Ireland.

The Marquis of Salisbury has been appointed President of the Board of Trade in succession to the **Rt Hon. Gerald W. Balfour, M.P.**, who has been translated to the Presidency of the Local Government Board.

The Hon. Alfred E. Gathorne-Hardy, deputy-chairman of the South Eastern R., has been appointed a member of the Railway and Canal Commission in succession to the **Rt. Hon. Viscount Cobham**, who has resigned. He has also been appointed chairman (unpaid) of the Light Railway Commission in succession to the **Earl of Jersey**, who has held this office since the Commission was created in 1896, and which, while it has been of considerable service to tramway promoters, has quite failed to accomplish the object for which it was established, namely, to facilitate the construction of light or feeder railways for the benefit of the agricultural industry.

Mr. Wm. B. Worthington, engineer-in-chief of the Lancashire and Yorkshire R., has been appointed engineer-in-chief of the Midland R. in succession to the late Mr. J. A. McDonald. Mr. Worthington commenced his career upon the L. and North Western R., and remained with that railway company until he joined the Lancashire and Yorkshire R.

Mr. Richard Evans, general manager of the Barry R., has resigned his office and has accepted a seat at the Board. In 1848 Mr. Evans entered the service of the Rhymney R. as a lad, and 40 years afterwards had risen to be assistant manager of the railway. At this time the Barry R. was about to be opened, and Mr. Evans was appointed general manager of it. The traffic was waiting for the railway to open, and 3,000,000 tons of coal were carried and shipped during the first year (1890) after the No. 1 dock was opened. Since that time the progress of the railway under the management of Mr. Evans has been continuous and most remarkable.

Mr. E. A. Prosser has been appointed general manager, **Mr. W. G. Griffiths** engineer, **Mr. Richard Jenkins** locomotive superintendent, and **Mr. J. S. Kendall** storekeeper of the Rhymney R. in succession to **Mr. C. Lundie**, who, up to the time of his elevation to the Board, held all these offices. All the above gentlemen have been, for some time, more or less conducting the business of the respective offices to which they have now been definitely appointed.

Mr. F. Wintour, district locomotive superintendent of the Great Northern R. at King's Cross, has been appointed to fill the vacancy at Doncaster, caused by Mr. D. E. Marsh going to the Brighton R., and not Mr. Maunsell as stated, by error, in our last issue. Everyone will be pleased to know that the company have been able to fill this post from their own staff, as the importation of officials from other companies has anything but an encouraging effect upon those who not unnaturally consider that they have a prescriptive right to promotion. For this particular appointment there were, we understand, considerably over 200 "outside" applicants.

Mr. R. J. Morrison, assistant manager of the Midland Great Western R. of Ireland, has been appointed goods manager, and **Mr. Thos. Elliott**, also of the manager's staff, has been appointed to be superintendent of the line. These are both new offices.

*

The Loco Packing Company.—Change of Address.

The London Office of the Loco Packing Co., and also of Mr. C. C. Braithwaite, has been removed from Moorgate Station Chambers to Finsbury Pavement House, E.C.

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Rating Appeals by the Great Northern Railway Co.

We are pleased to be able to record another successful appeal by the Great Northern R. Co. against an increased assessment. These continued victories should encourage Mr. A. J. Brickwell, the company's surveyor, to institute others; they must

also be very gratifying to the shareholders, and ought to stimulate other railway surveyors to prosecute similar crusades.

Railway companies cannot object to increases in the poundage rates, but they can appeal against increased assessments, and it is from increased assessments that railway companies suffer most. Rating authorities do not like to increase the poundage because that brings the burden too near home, on to their own backs in fact, and they much prefer to lighten their own taxes by raising the assessments of railway companies.

In this particular instance the Assessment Committee of the Grantham Union recently raised the assessment of the Great Northern R. Co.'s property in that Union, consisting of 11 miles of the main line to York, 22 miles of the Nottingham, Lincoln, Sleaford and Woolsthorpe branches, together with 9 stations, &c., from £34,130 (most of which were settled in 1875) to £62,034. The company appealed, and the matter was referred, by agreement, to the Recorder of Grantham, Mr. T. S. Soden, to arbitrate.

The enquiry, which was opened at Grantham and then adjourned to London, occupied 6 days. Certain items, principally stations, had been agreed between the parties, and these increased the former assessment by £2,119. The statutable deductions in every parish were also agreed. Over 20 parishes were affected by the appeals, the total figures (including the items agreed) put forward on behalf of the Assessment Committee being £67,823 against the figures proved on behalf of the company (also including those agreed of £25,405).

The arbitrator's award fixes the rateable value (including the agreed figures) at £37,040, which is £24,994 less than the assessment appealed against, and adds only £791 to the original rateable value of the line of railway. In 12 parishes the original assessments have been reduced. With the exception of the costs in respect of Grantham Station, and which the parties after the hearing had proceeded a short time, the arbitrator orders the Assessment Committee to pay the costs.

Mr. Ernest Page, K.C., and Mr. W. C. Ryde, instructed on behalf of Mr. A. H. Malim, Town Clerk of Grantham, appeared for the Assessment Committee; and Mr. J. H. Balfour Browne, K.C., and Mr. W. J. Noble, instructed by the company's solicitor (Mr. R. Hill Dawe), appeared for the Great Northern R. Co., whose expert witnesses included Mr. A. L. Ryde (Ryde and Sons, 29, Great George Street, S.W.); Mr. P. M. Faraday (Faraday and Rodgers, 77, Chancery Lane, W.C.); Mr. A. J. Brickwell, surveyor to the G.N.R.; Mr. Henry Escritt, Grantham; Mr. J. W. Rowe, Peterboro; Mr. D. E. Marsh, locomotive engineer L.B. and S.C.R., and late assistant locomotive engineer G.N.R. Co.; Mr. G. Whale, chief mechanical engineer L.N.W.R. Co.; Mr. J. G. Churchward, locomotive engineer G.W.R. Co.; and Mr. T. R. Johnson, assistant engineer, Mr. C. L. Edwards, accountant, Mr. W. T. Weeks, stores superintendent, and Mr. A. Moscrop, horse superintendent, G.N.R. Co.

*

"The Engineer for the Time Being."

THIS is a very common phrase in engineering specifications, and has hitherto been supposed to mean that if the engineer at the time when the specification was signed left the work his successor would settle disputes. But Mr. Justice Bray has decided that this is not so, and that the "engineer for the time being" means the engineer in charge at the time when the difference arose, and him only, and not any engineer who may have been appointed since the difference occurred. The point arose in the case of Strachan *v.* the Cambrian Railways Co. The plaintiff was contractor for the construction of light railways, and the contract provided that "any dispute which may arise under this contract "shall on the completion of the works, and not before, be referred "to Alfred Jones Collin, or other the engineer for the time being "of the light railway, and his decision shall be final and conclusive." A difference arose and it was referred to Mr. Collin, who declined to act, partly because of ill-health and partly because he had a personal interest in one of the lines. Meantime Mr. Collin had ceased to be engineer to the Cambrian Railways, and Mr. McDonald had been appointed in his stead, and the dispute was referred to him, but Mr. Justice Bray decided that Mr. Collin alone could settle the matter, and this decision has since been upheld by the Court of Appeal. It will, of course, be quite easy to guard against the point arising again.

*

Accelerated Express Services; North-Western R.

IN connection with the new and accelerated express services between Euston, Birmingham and Wolverhampton: between Oxford and Cambridge direct; and between Manchester, Liverpool and the North and Eastbourne, Brighton and Hastings, to which we referred in our last issue, the L. and North-Western R. Co. have issued a most attractive time-table, the first page of which illustrates the present 2-hour method of travelling between Euston and Birmingham, the last page "how our grandfathers travelled," and the two inside pages the complete time-tables of the services above mentioned and the foreign connections with them. The 2-hour Birmingham expresses, the through Oxford and Cambridge expresses, and the through carriages between the North-Western line and Brighton and Eastbourne are printed in red. The L. and North-Western is evidently preparing for the big fight which in the near future will take place for the London-Birmingham traffic. From the 2-hour Birmingham expresses leaving Euston at 11.50 a.m. and 4.45 p.m. carriages are slipped for Leamington and Warwick, and which make the journey in 1h. 52mins. and 1h. 57mins. respectively.

*

The Simplon Tunnel.

THE headings of the Simplon Tunnel met on 24th February. The tunnel is the longest in the world, being 12¼ miles long. It is quite straight except for slight curves at the ends. The headings were commenced simultaneously at the Italian and Swiss ends in November, 1898. Eventually the tunnel will consist of twin tunnels, with a single line in each, but only one tunnel will be completed at first. According to the contract one tunnel should be finished by the end of this month. The contractors are Brandt, Brandau and Co., Hamburg, and but for unexpected difficulties, particularly the tapping of enormous springs of hot, almost boiling, water which flooded the headings and stopped the work for several months, the tunnel would have been finished long ago. The gradients are much easier than they are in Mont Cenis or St. Gothard tunnels. The Italian end rises at 1 in 143, and the Swiss end at 1 in 500. The gradients meet at about the middle of the length, where there is a level length about 500 yards long. The summit is only 2,313 ft. above sea level, but at one place the tunnel is 7,000 ft. below

the surface of the earth. The section is 18 ft. high by 16½ ft. wide. The cost of the Simplon Tunnel is less per cubic yard than either of the other Alpine tunnels because of the improved mechanical appliances that have been available. The strata driven through were mostly hard gneiss and schist. The contract price for making the single-line tunnel and the lateral ventilating gallery (which will subsequently be enlarged into the tunnel for the other line) is £2,326,000. The opening of the Simplon Tunnel will have far-reaching effects upon international traffic. The distance between London and Italy by it will be reduced by about 60 miles as compared with the St. Gothard route.

*

Great Central Railway; removal of Offices to London.
On the 25th ultimo offices of the general manager, the chief engineer, and the superintendent of the line were removed from Manchester to London, and all communications for Mr. Sam Fay, Mr. C. A. Rowlandson, and Mr. R. Haig Brown respectively should be addressed to them at Marylebone Station, London, N.W.

*

Metropolitan Railway Electric Service.
On the 21st ultimo a trial trip with an electrically operated train was made over the whole of the Metropolitan R. Co.'s portion of the Inner Circle, viz., from Baker Street Station to South Kensington, back to Aldgate, and returning to Baker Street. The trial was satisfactory, and indicates that this company is ready to commence electric working on the Inner Circle.

*

Extension of City and South London R. to Euston.
The contract for this work has been let to Messrs. Walter Scott and Middleton, and when it is completed it will be of great value to the L. and North Western R., because Gower Street Station is too far away to be convenient.

Books, Papers, and Pamphlets.

The Elements of Railway Economics.—By W. M. Acworth, M.A. London: Oxford University Press Warehouse, E.C. New York, 91-93, Fifth Avenue. 1905.

The author states that during the nine years he has lectured on Railway Economics "he has constantly been hampered by the "want of an English text-book of the subject." As he has been prevented from completing the book he had planned, and as no one else fulfilled his hope by writing one, he has written the excellent little work before us, but which he himself very modestly describes as "an incomplete fragment."

It is true that the book is not an exhaustive treatise, but our difficulty is to find expressions sufficiently complimentary to apply to it. There is no redundancy about it, and its pages are as full of instruction as the proverbial egg is of meat. One reaches the last page with regret and with a desire for more.

The introductory chapter describes what a railway is and what its functions are and wherein they differ from those of a canal, omnibus, or steamboat.

Chapter II. is devoted to a consideration of railway capital and how it has been invested.

The next three chapters deal with railway expenditure, in the first of which railway expenditure is reduced to four general heads, viz., general charges, maintenance of ways and works, maintenance of rolling stock, and traffic expenses. To the consideration of the first and second and the third and fourth of these heads chapters IV. and V. are devoted respectively. Stress is laid upon the paucity of figures available from British railways as compared with foreign lines, and it is shown what the abstracts B. and D. of an English (the L. and S.W.R.) company's accounts have been expanded into by English railway men "free "from the fetters of a statutory form of accounts, fixed 40 years "ago, and practically unchanged since." The accounts of the Buenos Ayres Western R. are taken as a comparative example.

The two following chapters deal with railway income, and discuss some impracticable methods of charging for transport, and demonstrate that "to claim that rates shall automatically be fixed on the basis of cost of carriage is to claim what is impossible." The claim for "equal mileage" rates is also shown to be a bad one.

Chapter VII. sketches the historical development of railway income, and brings us to one of the most interesting in the book, viz., Chapter VIII., on "charging what the traffic will bear," and in which the author shows the justice of this principle, and supports it by a chapter of telling analogies recounted in Mr. Mr. Acworth's well-known attractive style.

Classification occupies Chapter X., and the methods of charging Chapter XI., while the interference of Parliament with classification and rates is the subject of the last chapter, in which the author shows that the effect of Parliament fixing maximum rates has been to prevent the lowering of rates, because managers will not risk reducing a rate in case they might want to raise it again, and would not be able to do so without a law suit.

"Economics" has a "dry" sound, but when expounded by Mr. Acworth's pen it becomes quite a fascinating subject.

*

Petroleum. By Sydney H. North. London and Newcastle-on-Tyne: The Walter Scott Publishing Co., Ltd. 1904.

This is an instructive little work which deals with the subject under the following heads:—Origin of Petroleum, Chief Oil-fields of the World, Geological Conditions, Composition of Crude Oil, Refining the Oil, Drilling for the Oil, Testing Petroleum, Oil for Motors, Oil for Fuel Purposes, Petroleum on the English Market, Transport and Storage, and an Oil Property and its Management. There is also an appendix consisting of a tabulated statement showing the yearly productions of the various oil-fields from 1860 to the present time.

*

Books Received.

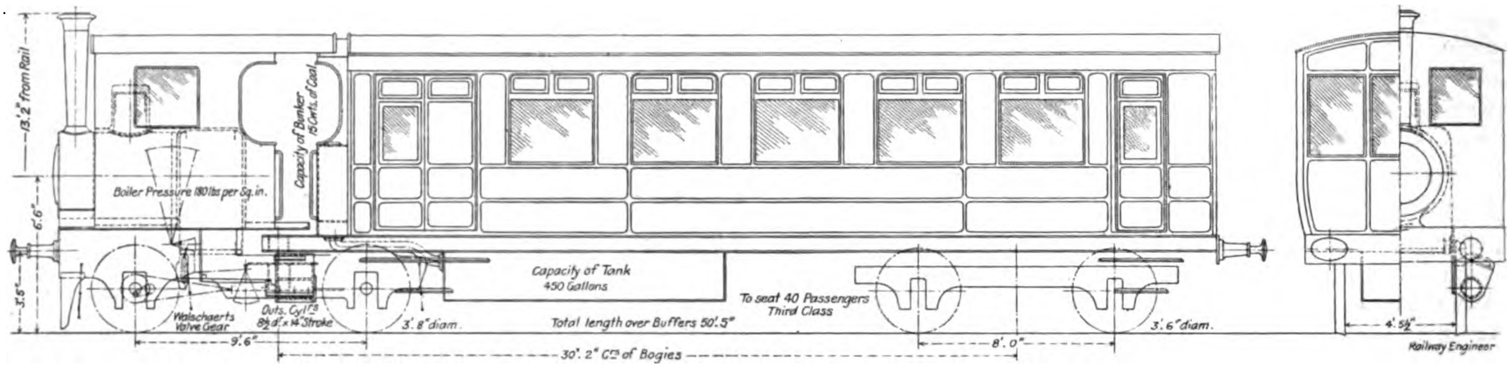
British Standard Specification for Structural Steel for Marine Boilers.
British Standard Specification and Sections of Flat-bottomed Railway Rails.
Temperature Experiments on Field Coils of Electrical Machines carried out at the National Physical Laboratory.
Reports issued by the Engineering Standards Committee, Leslie S. Robertson, M.Inst.C.E., secretary. London: Crosby, Lockwood and Son, 7, Stationers' Hall Court, E.C. December, 1904. [Price 2s. 6d. net each.]

Gas and Oil Engines. An elementary instruction book for amateurs and engine attendants. By Walter C. Runciman. London: Percival Marshall and Co., Poppin's Court, E.C. [88 pp.; price 6d. net.]
This is one of the Model Engineer Series, and its contents are truly in accord with its title. It is illustrated by a number of diagrams, which are clear and quite sufficient for the needs of the work.

Publications of the British Fire Prevention Committee. Edited by the Executive. London: Published at the Offices of the Committee, 1, Waterloo Place, Pall Mall. [Price 2s. 6d. each.]

No. 82. *The Standards of Fire Resistance of the British Fire Prevention Committee*, as adopted to serve as universal standards at the International Fire Prevention Congress, London, 1903, with translations into German and French, together with special tables of measurements, weights and temperatures converted into their metric equivalents.

The Committee's Reports on Fire Tests:—
No. 84. *Partition* formed with Jabez Thompson's Patent "Terrawode" Brickwood, and erected by Jabez Thompson, Northwich, Cheshire.
No. 87. *Automatic Sprinklers* submitted for test by the Albion Sprinkler Company, Ltd., London.
No. 88. *Partition* formed with "Kulm" Slabs, erected by Horace W. Cullum and Co., London.
No. 89. *Petrolite Lamp* manufactured by Petrolite, Ltd., London.



Steam Motor Carriages; North Staffordshire Railway.

By the courtesy of Mr. John H. Adams, locomotive engineer of the North Staffordshire R., we are able to publish the annexed diagram and particulars of two steam motor carriages which are being built by Messrs. Beyer, Peacock, and Co., Ltd., at Gorton, to his designs.

These carriages are, it will be noticed, of the "divided" type, the engine being separate from the carriage body. They are constructed to seat 40 passengers third class. They have outside cylinders with Walschaert valve gear and "single" driving wheels and a "loco" type boiler.

They are intended to work between Silverdale and Trentham, and to pick up and set down passengers at convenient places where there are not stations, but there are other sections that will be worked by similar vehicles should the first two prove to be successful.

We hope on future occasions to be able to give further drawings, but, in the meantime, the following particulars will be useful for the purpose of comparison with similar vehicles which have been built by other companies:—

Cylinders, 8½ins. diam. × 14ins. stroke.
Engine wheels, 3ft. 8ins. diam.; carriage wheels, 3ft. 6ins. diam.
Wheel base of engine, 9ft. 6ins.; of carriage bogie, 8ft.
Wheel base—total, 38ft. 11ins.
Centre to centre of bogie centres, 30ft. 2ins.
Length over buffers, 50ft. 5ins.
Weights (about) on the driving wheels (leading), 9 tons 15 cwt.; on the trailing engine wheels, 8 tons 5 cwt.; on the carriage bogie, 14 tons 10 cwt.; total, 32½ tons.
Boiler pressure, 180 lbs. per sq. in.
Coal bunker capacity, 15 cwt.
Water tank capacity, 450 galls.

Holzapfel's "Pintoff" Paint and Varnish Remover.

Many attempts have been made to supersede the time-honoured process of "burning-off" old coats of paint, enamel and varnish by the application of a liquid "paint remover," but so far as we are aware the compositions hitherto placed on the market have possessed or developed some inherent defect which has caused their use to be abandoned.

The principal troubles experienced with them in railway work —particularly carriage work—have been the injury done to the pins and screws fixing the panels, fascias, mouldings and fittings, and the "raising" of the grain of the wood. Some compositions have also been more or less injurious to the health or harmful to the hands and tools of the workmen, and others have left deposits which injured the new paint or varnish.

Holzapfel's Composition Co., Ltd., Newcastle-on-Tyne, are now introducing a new paint remover under the registered name of "Pintoff," and which appears, so far as we have been able to judge by practical experiments, not to possess any of the disqualifications above mentioned. "Pintoff" is of about the same consistency as cream. It is applied with an ordinary brush to the painted, enamelled, or varnished surface, and allowed to stand from 5 to 15 minutes, after which the surface is cleaned off with a stiff brush or painter's knife. Very old painted or varnished surfaces require the "Pintoff" to be left on them for a longer time, but it so softens the old paint—four or six coats—that it is readily removed with a knife leaving the surface clean, dry and smooth. For carved work and mouldings a stiff brush is the most convenient tool to use, and it is on such surfaces that "burning off" is most difficult to carry out, and, therefore, on which the use of "Pintoff" would produce greatest economies.

After the "Pintoff" has been cleaned off it is recommended that the surface should be wiped over with cotton waste saturated with methylated spirits, benzine or turpentine, or if neither of these be available water may be used, after which the surface is, immediately it is dry, ready for the new coat of paint or varnish.

"Helios" Patent Die-Stocks.

An interesting mechanical movement has been introduced into the "Helios" stocks and dies, which are illustrated by figs. 1 to 4, and from which it will be seen that four dies are placed in a square frame in such a way that the movement of one die operates the other three.

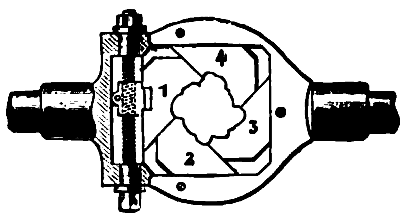


Fig. 1.

By reference to fig. 1 it will be seen that the die 1 engages with a projection on a nut which traverses on the operating screw through the stock, and the adjacent sides of the dies making angles of 45° to the sides of the frame it follows that the movement of die 1 in either direction to or from the central position gives a corresponding and simultaneous movement to each of the other dies whereby they are opened or closed.

The dies are set with accuracy by the micrometer reading (for both right and left hand threads) on the frame and the index on the collar of the operating screw shown on fig. 2.

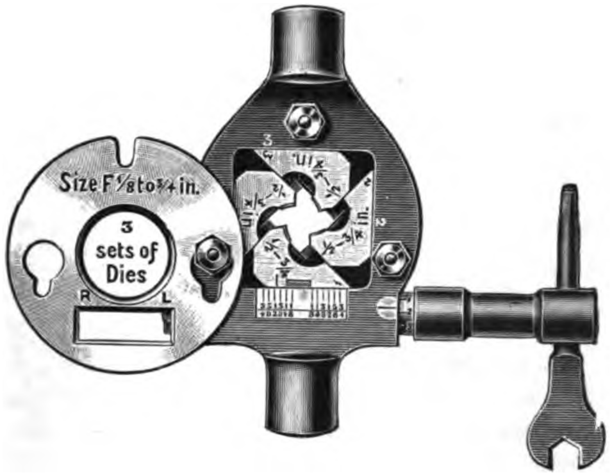


Fig. 2.

These marks enable pipes or bolts to be screwed to the same diameter, standard or otherwise, and are particularly useful in repair work where pipes have to be screwed to fit old connections.

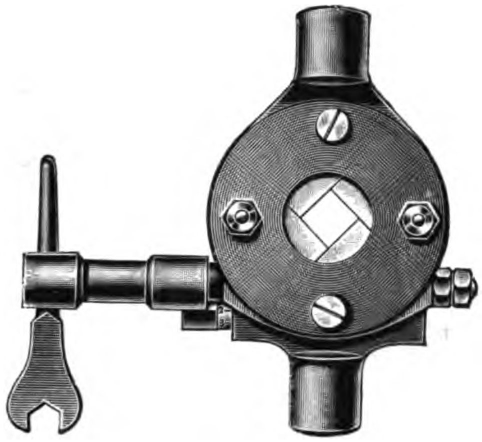


Fig. 3.

The dies are held in the stock by a cover plate (see fig. 2), which is readily removable and which also protects the micrometer marking.

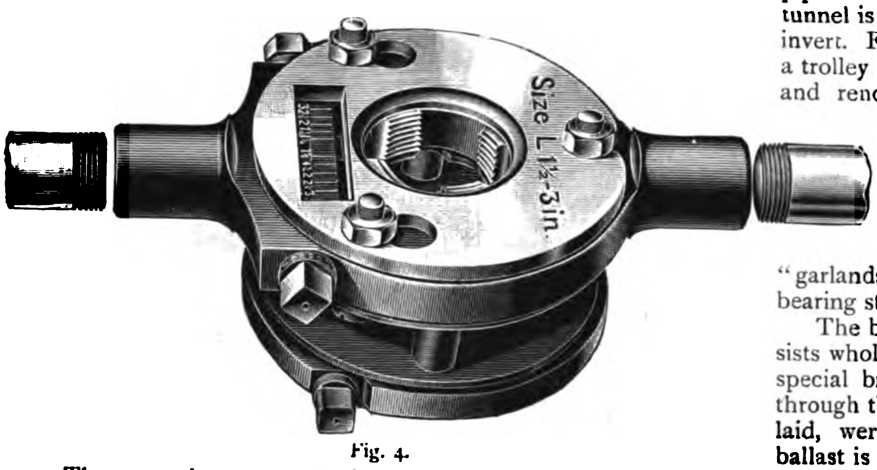


Fig. 4.

These stocks are made in seven sizes; the smallest will screw from ⅛ in. to ¾ in. and the largest from 3 ins. to 4 ins., but as the sizes overlap any two sets will cover a wide range, *e.g.*, from ¼ in. to 3 ins.

The dies are made of a special tool-steel and in such a way that they cut the full depth of thread in passing down the work once. They are then opened and the stock lifted off, thus saving the time usually lost in turning off the work. Neither is it at all necessary to prepare or champher the end of the work in any way.

The stocks are also provided with a patent removable guide, shown in figs. 3 and 4, and which is made adjustable on the same principle as the dies. This enables a pipe or bar to be screwed perfectly square without the necessity of trueing up the end. The guide can also be used as a tap wrench.

Screwing machine heads are also made with the dies, moved upon the same principle except that a lever is used instead of a screw.

Further particulars of these tools may be had from Mr. S. Stone, 75, Finsbury Pavement, London, E.C.

Alfreton Second Tunnel.*

THE Alfreton Second Tunnel was undertaken in 1899 as part of the Midland R. Company's scheme for widening their main line in Derbyshire. The new tunnel is 90 feet from the old, and, like it, is ½ mile in length. The tunnel cuts through the coal measures, and several beds of coal were met with, from which fuel for the contractors' engines, &c., was obtained.

Owing to the extensive cuttings required at both ends of the tunnel it was not possible to attack it from the ends; five shafts were therefore sunk on the centre-line, and from these the whole of the tunnelling was done. The tunnel was driven of full size in both directions from each shaft, but when the working-faces had approached to within 2 chains of each other a small heading was driven through in order that the alignment and levels might be checked. In no case was there any appreciable error, although the only instrument used for setting-out the centre-line was an ordinary 5-inch transit theodolite.

The tunnel is built of red bricks procured in the locality, and is faced internally with best Staffordshire brindle bricks. The thickness of the tunnel-ring is 2 feet 3 inches, except for a few lengths in which it is 2 feet 7½ inches, and the shaft lengths, which are 3 feet thick. Most of the tunnel was worked in lengths of 15 feet, but at one point these had to be reduced to 12 feet, owing to extra pressure on the timbering.

A good deal of water was met with in driving the tunnel, and in order to drain this away from the working-faces earthenware pipes were laid below the invert. The permanent drainage of the tunnel is effected by means of a 2-foot brick culvert built on the invert. For turning the arch of this culvert, centering mounted on a trolley was used. This effected a considerable saving in time, and rendered it possible to build the culvert at the rate of 44 lineal yards per day. The drainage of the shafts is effected by means of earthenware pipes built in behind the brick lining of the shafts and tunnel, and discharging into the tunnel at rail-level. The water which accumulates around the shaft-lining is collected and led to these pipes by means of brick "garlands" encircling the shaft-linings just below the water-bearing strata.

The brickwork at the intersections of shafts and tunnel consists wholly of blue bricks in cement, the arris being formed of special bricks made to the proper angles. The permanent way through the tunnel consists of 100-lb. rails, which, before being laid, were painted with four coats of red-lead paint. The ballast is of slag.

Special care was taken, in designing and building the tunnel-fronts, to avoid the failures which sometimes occur at these

*Abstract of a paper by Mr. E. F. C. Trench, M.A., B.A.I., read before the Institution of Civil Engineers, February, 1905.

places. The face-wall was built to a batter of 1 in 6, and in order that the brick courses of the tunnel-ring might be brought in normally to this batter the tunnel was given a bell-mouth, the vertical axis being increased in length by 2 ft. at the face. To increase the longitudinal strength of the tunnel hoop-iron straps were built between the brick courses at each face.

The time occupied in building the tunnel was nearly two years. The works were carried out at the direction of the company's engineer, the late Mr. J. A. McDonald, M.Inst.C.E. The contractors were Messrs. Thomas Oliver and Son, and the author acted as resident engineer.

Tool Stands for Work Shops.

THE annexed illustrations show two patterns of Tool Stands, which are a useful speciality manufactured at Slough by the Consolidated Engineering Co., Ltd.

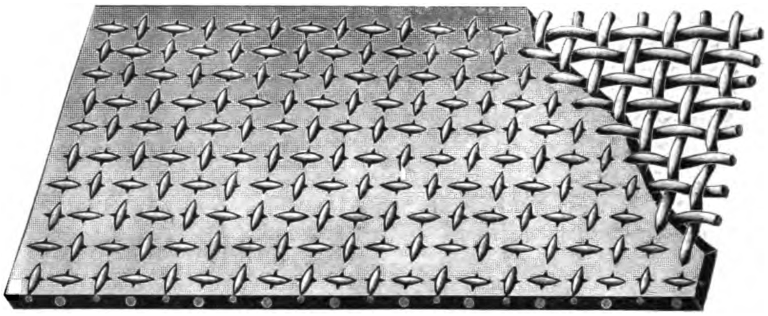
These stands form convenient receptacles for tools, accessories and partly finished work, which, when not laid on the floor, are commonly deposited on the machine beds, which, unless carefully protected, are soon seriously damaged thereby.

The stands are from 2 ft. 6 ins. to 3 ft. high, and occupy but little floor space, and contribute greatly to the orderly appearance of a shop. They are very strong and light, the trays being stamped out of steel $\frac{3}{32}$ in. thick and the uprights consisting of wrought-iron tube. Besides being made as shown in the illustrations, they are also made with castor feet, which renders them very portable. We have heard these stands very highly spoken of by those who have them in use in their shops.

"Steelead" Stair Treads.

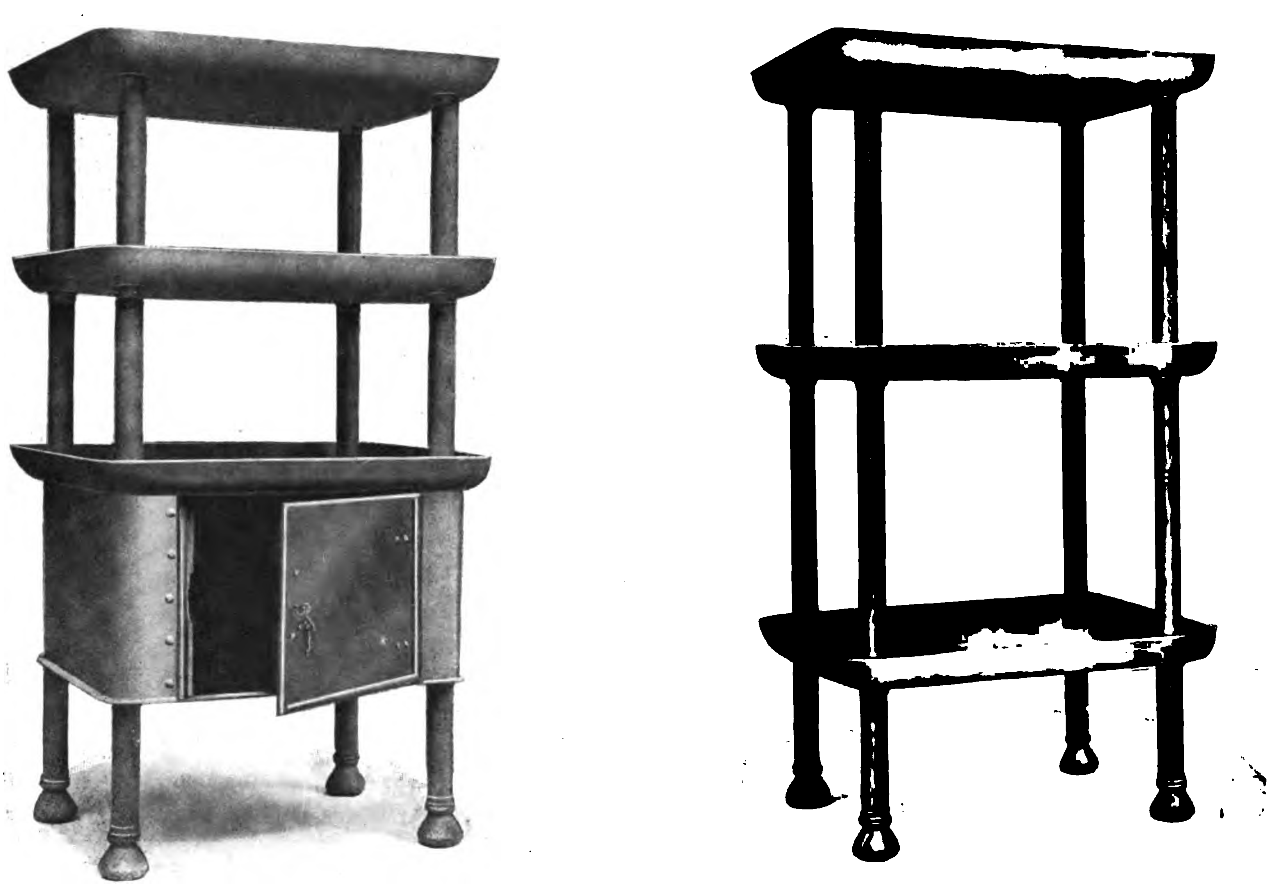
WE illustrate herewith a non-slipping stair-tread which is being largely used by several railway companies. It combines great durability with all the advantages of a plain sheet of lead.

The steel wire is made up into a stout woven mesh and the lead completely incorporated with it by means of enormous hydraulic pressure. The construction of the resultant material is well shown by the illustration.



This tread cannot spread out or "wrinkle" and become dangerous, as sheet lead is so liable to do. It is easily fixed by means of nails or screws and readily adapts itself to worn treads of either wood, stone or iron.

It is manufactured by the Consolidated Engineering Co., Ltd., of Slough, who will supply any further information that may be desired, and who are just now filling an order for 150 square yards of it for one of the leading home railways.



Tool Stands for Workshops.

An Attempt to Show Graphically the Deflections and Bending Moments in the Britannia Tubular Bridge as described in Clarke's Book, Vol. II.

The bending moment in the centre of the long span from dead load alone is found as follows :—

$Wl \div 8$ = 1,553 tons × 460 ft. ÷ 8 = 89,272 ft. tons, and this (Clarke p. 673) gave a mean central deflection of 12·57 ins.

The bending moment in the centre of the short span from dead load is found as follows :—

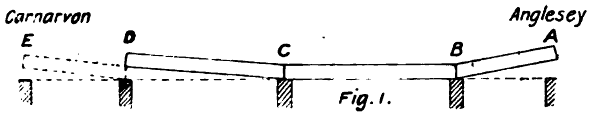


Fig. 1.

$Wl \div 8$ = 600 tons × 23 ft. ÷ 8 = 17,250 ft. tons.

"The deflection of the land tubes due to dead load only was not ascertained as they were united to the large tubes before they were allowed to take the deflection from their own weight." (p. 764.)

When all the tubes were placed in position ready for connection over the three piers or points of support B, C and D, fig. 1, the first proceeding was to raise the end of the Anglesey short tube $14\frac{5}{8}$ ins., join it to the adjoining large tube and lower it to its former bearing.

This raised the centre of the tube B C 1·89 ins., which, on the principle that the deflection varies as the stress, may now be drawn to scale on a diagram, figs. 2 and 3.

The junction of the two tubes A B and B C now being accomplished, the end D of the second long tube was raised $31\frac{1}{2}$ins. from its bearing, and the junction C was now made. As soon as this was done the extremity D was lowered, and this was found to raise the centre of tube B C 1·57 ins. more, and also to raise its own centre 2·35 ins., whilst the small tube A B had its deflection slightly increased.

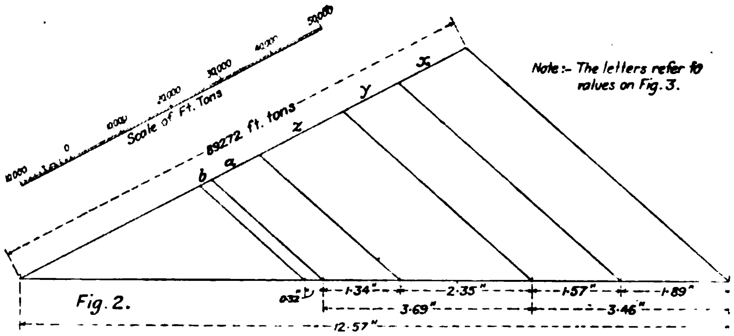


Fig. 2.

The short tube E D was then raised $14\frac{1}{2}$ ins. at E, and in this condition was united at D, and lowered to its permanent bearing.

This raised the centre of D C 1·34 ins. more, or a total of 3·69 ins., and the deflection in the other long tube C B was raised 3·46 ins.

But this, while it raised the centre of D C 1·34 ins., also had the effect of lowering the other long tube C B 0·32 in., and again this downward motion of the long tube had a perceptible effect in raising the adjacent short tube A B.

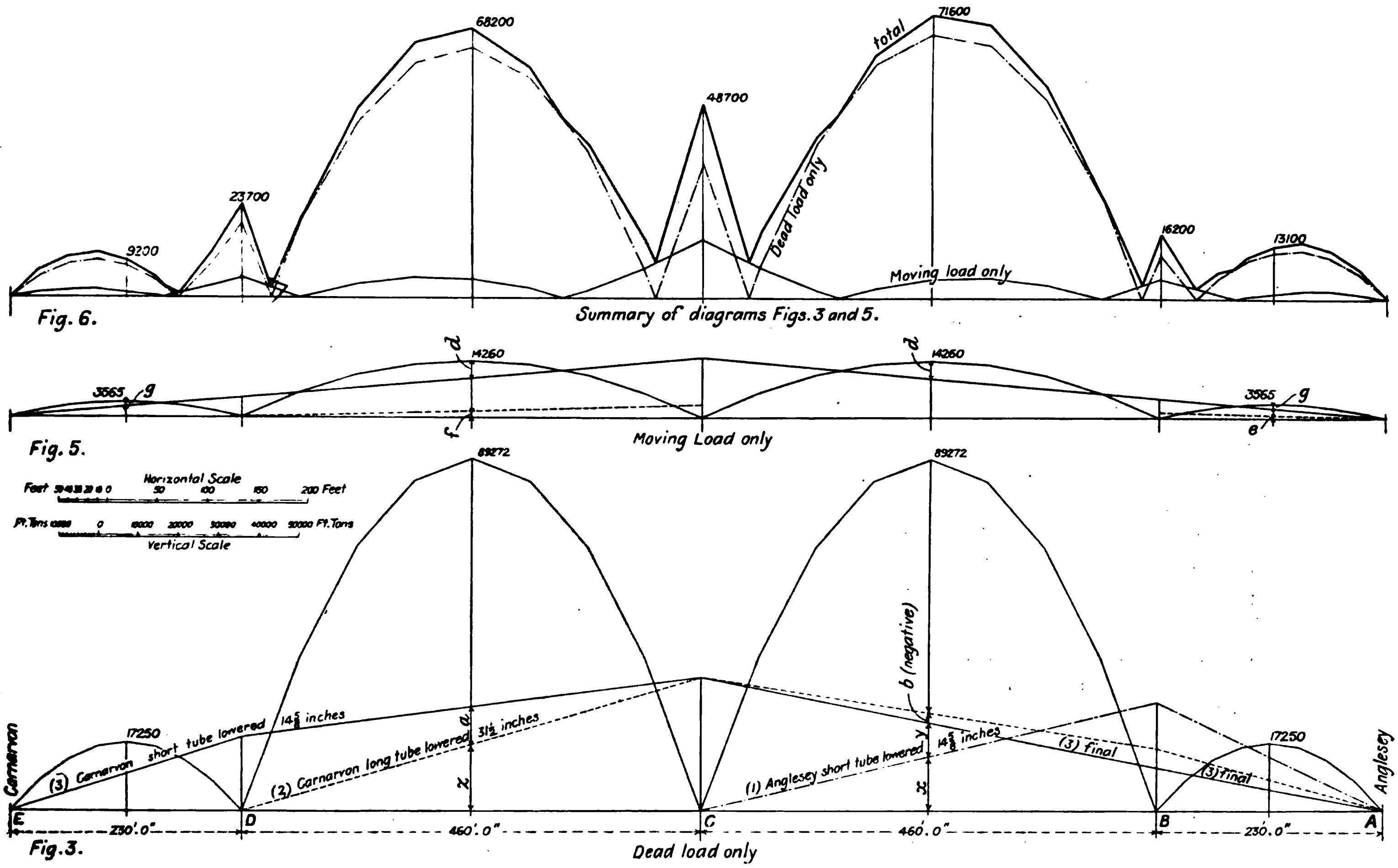


Fig. 6. Summary of diagrams Figs. 3 and 5.

Fig. 5. Moving Load only

Fig. 3. Dead load only

Now consider the moving load as exemplified on page 709 of the book—

The bending moment in the long tube due to moving load was

$Wl \div 8$ = 248 tons × 460 ft. ÷ 8 = 14,260 ft. tons.

and the bending moment for moving load in small tube was

(load = 248 tons × 230 ft. ÷ 460 ft. = 124 tons) =

124 tons × 230 ft. ÷ 8 = 3,565 ft. tons;

the mean deflection of one long tube under the moving load was ... ... = 0·676 in.

and this raised the other long tube ... ... = 0·19 „

and the adjoining short tube ... ... = 0·109 „

and it was also noted that the deflection of the short tube under the above load was... ... = 0·141 „

By the principle of proportion it may be taken that if the mean deflection of the long tube discontinuous was 12·57 ins. for 1,553 tons dead load, then for the 248 tons additional moving load it would have been—

$$12{\cdot}57 \times 248 \div 1553 = 2{\cdot}01 \text{ ins.},$$

but the long tube did not deflect to this amount, but only 0·676 ins., and now the reduction in the bending moments due to the continuity may be obtained by fig. 4 below, and diagram fig. 5 can now be drawn.

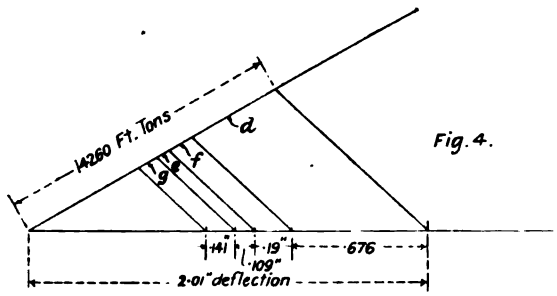


Fig. 4.

Another diagram (fig. 6) showing the final effect of the dead and moving loads will naturally follow.

It is now desired to find the unit stress in the flanges.

The flange areas and outside depths of the tubes are given in the book (page 588), but the depth centre to centre of the series of cells should be taken in the calculation.

This is given on page 759 as 27 ft. 6 ins. in the centre of the long span and in decimal figures this reduces the depth 29·29 ft.—27·50 ft. = 1·79 ft.

Taking this amount from the outside depth is assumed to give the virtual depth in all cases.

With these values of depth and area the stress can be obtained from the bending moments already found.

This at the centre of the large span, and with the deflection of 12·57 ins., is

89,272 ft. tons ÷ 27·5 ft. × 585·43 sq. ins. = 5·545 tons to the sq. inch.

The following table can now be made, the stress being modified according to the depth and area at each point.

Points.	(*a*) Bending moments from diagram Fig. 6. ft.-tons	Outside depth. ft. ins.	(*b*) Virtual depth. feet.	(*c*) Area. sq. ins.	$a \div b \times c$ = stress in tons per sq. in.
Centre of short span	13,100	25 2½	23·41	414·55 (bottom)	1·35
Land tower ...	23,700	27 0½	25·23	592·49 (top)	1·59
				359·76 (bottom)	1·62
Centre of long span	71,600	29 3½	27·50	585·43 (bottom)	4·44
Britannia tower ...	48,700	30 0	28·21	618·89 (top)	3·79
				575·24 (bottom)	3·co

In the flange area no deduction is made for rivet holes.

The Strength of Timber Treated with Preservatives.*

Effect of Preliminary Steaming and of Different Preservative Chemicals and Processes upon Both Green and Seasoned Timber.

With the increasing use of timber, preserved in one way or another against decay and fire, it is important to determine the effect which the preserving process has upon the strength of the preserved timber. Many engineers believe that creosoted timber is more brittle and less capable of withstanding strains than the same timber before being treated with creosote. This is particularly true with bridge timbers and piling.

Actual tests are necessary to determine what relationship exists between the preservative process and the strength of the timber. Most of the tests hitherto made with preserved timber were made by comparing results of tests on treated sticks with results on untreated sticks. In many instances these turned out in favour of the untreated timber. The reason why such tests are unfair to the preservative is that in the process of preservation two factors enter: (1) The actual process of impregnation with a preserving substance, and (2) The preliminary processes of steam seasoning, in the majority of treating plants in the United States. A piece of timber subsequently treated with creosote may be steamed to such an extent that the timber becomes exceedingly brittle. This, obviously, will be the fault of the steaming and not of the creosote.

Timber preservation divides itself broadly into three stages: First, the preliminary preparation; second, the actual preservative process; and third, the treatment of timber following preservation. The final strength of the timber may be influenced materially by each of the stages.

The Bureau of Forestry has erected an extensive plant on the grounds of the St. Louis Exposition for carrying on a series of investigations of the methods for preserving timber, and of the influence various preservative processes have upon the strength of the timber. These investigations have been organised and outlined by Doctors von Schrenk and Hatt, of the Bureau of Forestry.

This general plan was pursued during the last few months at the timber treating and testing station at St. Louis in accordance with the following outline:

(1) To determine the effect of the preliminary processes, such as steaming, on the mechanical properties of the timber.

(2) To determine the effect of preservatives on the strength of timber, eliminating the effect of the preliminary processes.

In order to determine the effect of these factors, the programme was divided into two parts—part 1, the effect of the

*Issued from the Bureau of Forestry of the Department of Agriculture of the United States Government.

preliminary process, and part 2, the effect of preservatives.

The effects of the preliminary process were determined only on loblolly pine. Both green and seasoned timber was used in determining the effect of preservatives. The preservative fluids investigated included only creosote and zinc chlorid.

In making comparative strength tests of treated and untreated timbers, it is necessary to eliminate as far as possible the variations due to the great differences in quality of individual pieces of wood. This was accomplished in this case by using 11-foot timbers cut at the same time from one forest site. In testing the influence of preliminary processes of seasoning, a 3-foot section was cut from one end of each timber and sawed up into test pieces, which furnished a basis of comparison between (1) the results of tests on these "control" pieces, and (2) the results on test pieces taken from the remaining 8-foot section after the latter had been subjected to the various preliminary seasoning processes in the treating cylinder.

In testing the effect of preservatives themselves the entire 11-foot timber was subjected to the preliminary seasoning processes, after which a 3-foot section was cut from the end of each timber. The 3-foot section thus having been subjected to the preliminary seasoning processes formed a basis of comparison with the remaining 8-foot section, which was treated with the preservatives. In this way the separate effects of the preliminary processes and the effects of the preservatives could be isolated and determined.

Because of an apprehension that defects of brittleness of treated timbers might not be evidenced by the ordinary tests under slowly applied loads, provision was made for both static tests and impact tests. The test pieces were subjected to crossbending strain, compression along the grain under both static and impact conditions, and under shearing parallel to the grain and compression at right angles to the grain under static conditions. The data taken include the moisture conditions, specific gravity, and rate of growth. During the treating operations, records were kept of the temperature to which the timbers were subjected at all stages, the amount of water lost or gained, and of the amount of preservatives absorbed, as indicated by gross weight and subsequent chemical analyses of the test pieces.

Ordinarily the strength tests were made immediately after treatment in the cylinder. In order, however, to determine what weakness might be introduced by changes in the physical condition of the preservatives in the wood through lapse of time, a complete series has been set aside for subsequent operations. An additional set of test pieces has been loaded with different percentages of the strength, as exhibited under the ordinary tests, and this load allowed to act for long periods of time, the deflections being measured from day to day.

While this programme is not sufficiently advanced to allow the drawing of final conclusions, yet the preliminary results are fairly indicative of what may be expected. It is found that the steaming process weakens the resistance of the wood fibre to both static and impact loadings. It may be stated that this diminution of strength is very nearly in direct proportion to the length of time that any given steam pressure is applied. The diminution of strength was found to be 25 per cent. after a pressure of 20 pounds was applied for ten hours to green loblolly pine, and 10 per cent. when a pressure of 20 pounds was applied for four hours. This diminution of strength increased very rapidly when the pressure rose above 20 pounds, and amounted to about 25 per cent. when a pressure of 50 pounds was applied for four hours.

It will be easily seen that when the conditions of time and pressure are made very severe, the conditions prevailing in a pulp mill industry will be approximated. Evidently it is well to avoid when possible the the use of these preliminary steaming operations in the wood preserving industry.

With relation to the effect of preservatives themselves, the latter is distinct from the preliminary process. It may be said that the treatment with zinc chlorid does not seem to further reduce the strength of timber beyond the effect of the steaming process. This might have been expected when it is considered that the strength of the zinc chlorid solution ordinarily used does not exceed 2½ per cent. The strength of timber that had been treated with the 2½ per cent. solution of zinc chlorid after having been steamed four hours at 20 pounds pressure was the same as that of timber which had been steamed without the subsequent application of zinc chlorid. The same statement may be made of timber treated with an 8½ per cent. solution of zinc chlorid. It may be that subsequently the crystallization of the zinc chlorid will weaken the wood fibre. This remains to be determined.

The effect of the creosote appears to be the same as that of an equal amount of water in weakening the fibre. That is to say, the strength of creosoted timber is that of green timber. The difference is that while green timber gains strength upon seasoning, the creosote oil remains in the wood, and, it appears from analysis of a pile 35 years old, that the oil remains in a liquid condition. Consequently, comparison between seasoned timber and creosoted timber will always result to the disadvantage of the latter as far as its strength is concerned. In the case of creosoted wood, it also remains to determine what changes in the wood fibre take place through lapse of time in the presence of creosote oil.

It is expected that a bulletin will be issued upon the results of these investigations when the tests are completed. This bulletin will also contain the results of the investigations to determine the best methods of preserving wood so that the maximum impregnation may be obtained with the least expenditure of oil per cubic foot of timber.

Pullman Car Framing.

The present design of body-framing adopted by the Pullman Palace Car Company for their cars is illustrated by fig. 1.

The sides of the car below the lights are built up with the underframe to form a girder. The length over sills is 72 ft. and between the centres of bogies 56 ft. The bogie wheelbase is 10 ft. 6 ins.

The side sills, 8 ins. × 6 ins., are spliced over the truss post, the splice on one side being placed out of line with that on the other side, as shown on the plan of floor framing. The middle sills, 6 ins. × 4½ ins., are also spliced and break joint

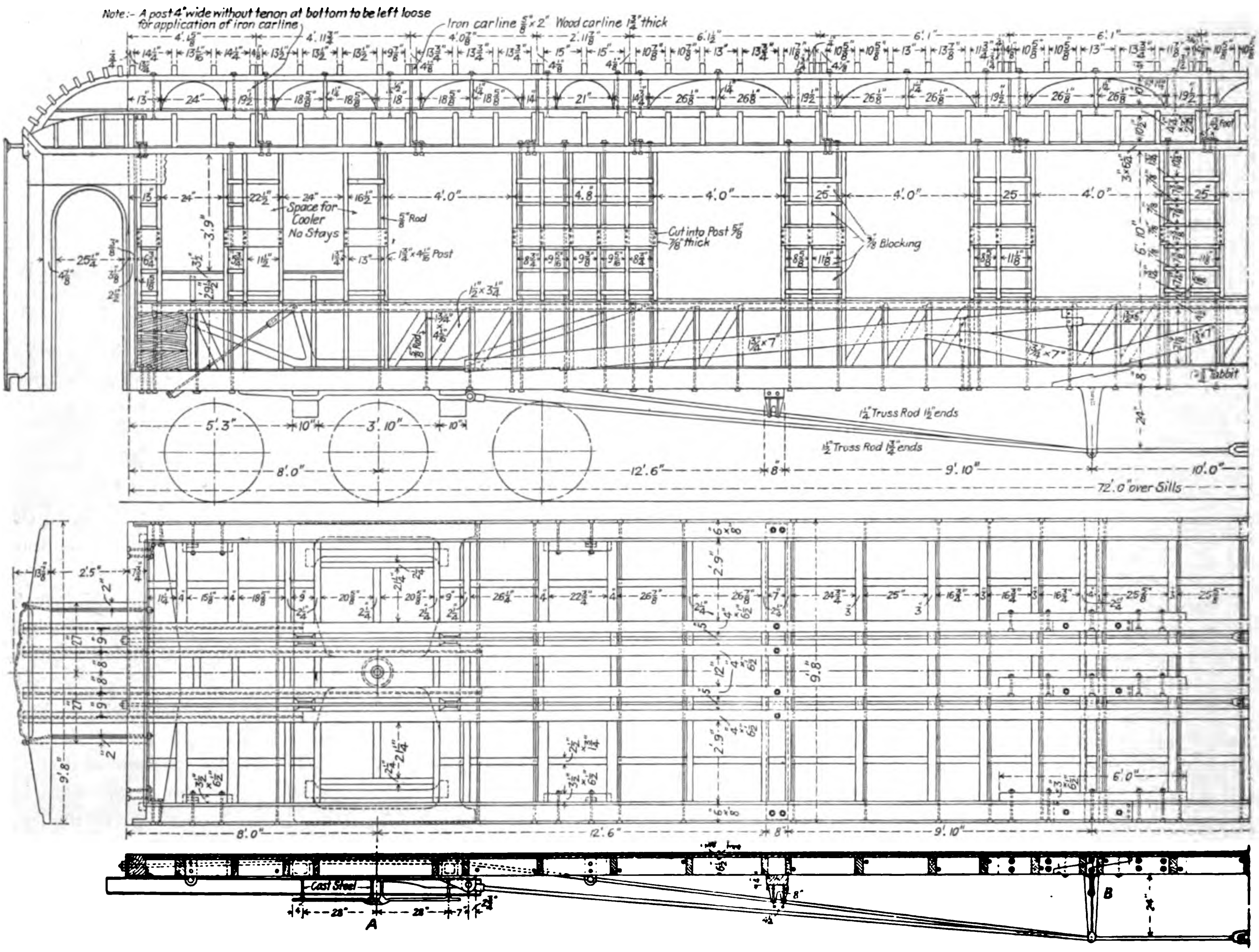
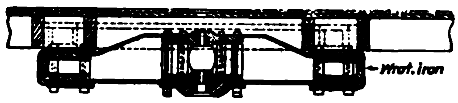
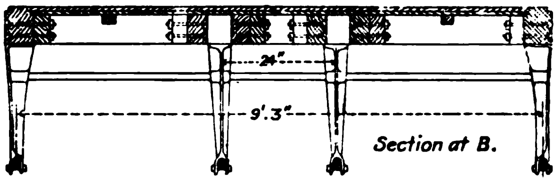


Fig. 1.—Body Framing adopted by



Section at A



Section at B.

in a similar manner. All the spliced joints are strengthened by bolting a length of timber $6\frac{1}{2}$ ins. × 3 ins. along one side of them.

A frame of wrought iron, 3 ins. × $\frac{5}{8}$ in., is fixed over the bogie. The bottom member of this frame rests on the side sill, while one nearly vertical and two diagonal members connect the top member, which is $2\frac{1}{2}$ ins. × $\frac{5}{8}$ in., and which runs the entire length of the car and is fixed to the waist rail.

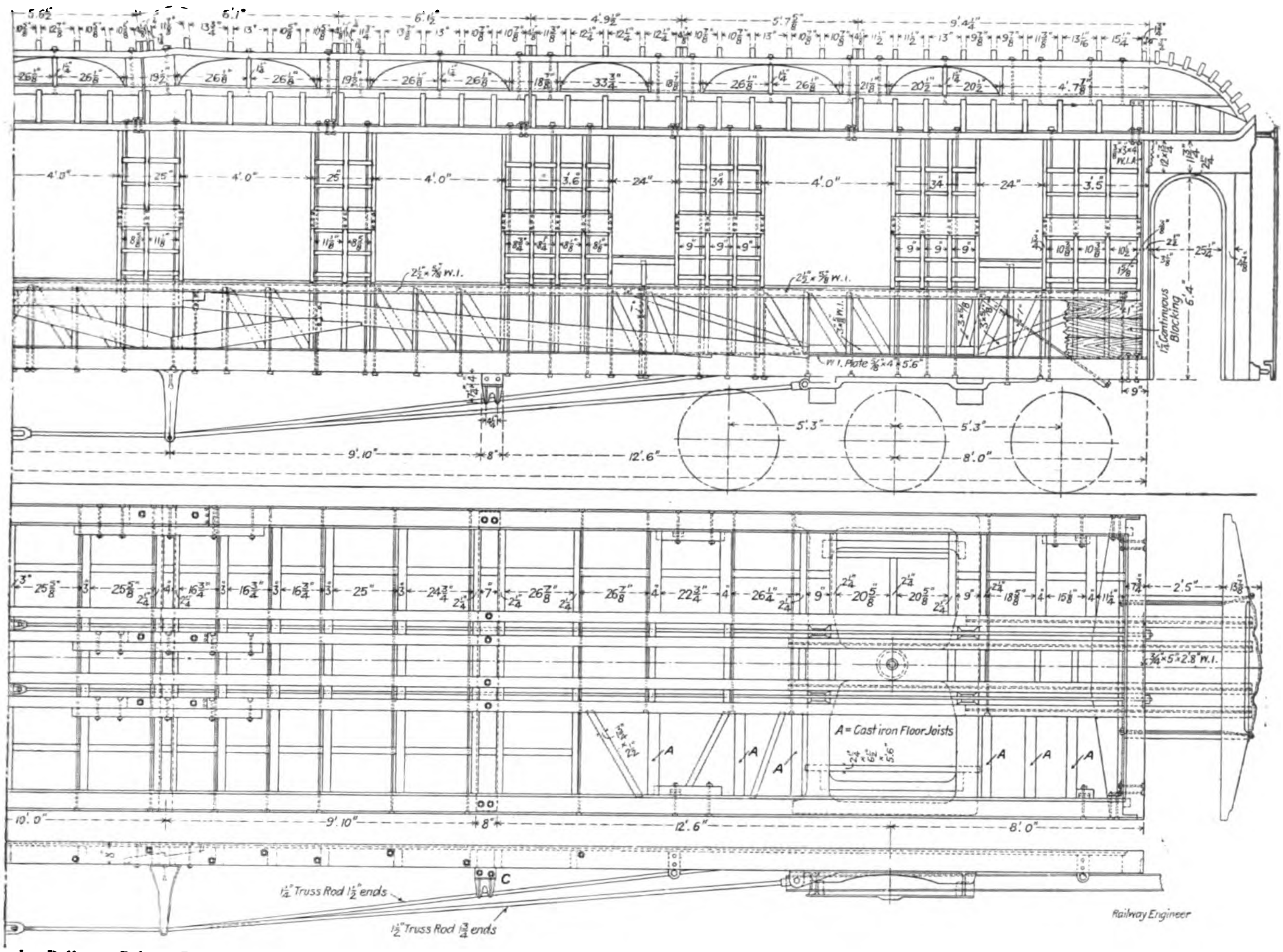
The sides are framed to form a queen truss; the timber bracings are 7 ins. × $1\frac{3}{4}$ ins., the end pieces are double notched on to the side sole, and timber of the same section is built in to complete the trussing above and between the queen posts for the floor trussing.

Pillars, $4\frac{1}{16}$ ins. × $1\frac{3}{4}$ ins., are placed at short intervals, with struts $3\frac{1}{4}$ ins. × $1\frac{1}{2}$ ins., the whole being bolted together with $\frac{5}{8}$ in. bolts, those between the windows passing through the cant rail.

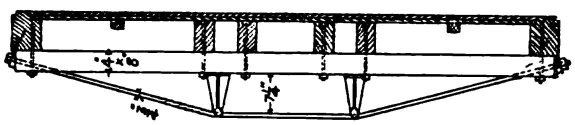
The sides are further stiffened by $1\frac{1}{4}$ ins. boards or "continuous blocking," running the whole length of the car.

The arrangement of the floor framing is shown by the plan; the middle timbers run through from end to end of the frame, with trimmers between them and the side soles, transverse tie bolts being used freely.

The bogie centres or bolsters are of cast steel bolted below the framing. The floor framing is stiffened by four truss rods, which are 2 ft. below the sills, the length of the carriage necessitating a greater depth than is usual in this country. The side truss rods, $1\frac{1}{2}$ ins. diam. with $1\frac{3}{4}$ ins. ends, are secured to the bogie centre casting, and the middle rods, $1\frac{1}{4}$ ins. diam. with $1\frac{1}{2}$ ins. ends, are carried above the bogie casting and through the end sills, into which a wrought iron washer plate, $\frac{3}{4}$ in. thick, is let in flush with the timber to give the nut a good bearing.



the Pullman Palace Car Company.



Section at C.

Transverse truss rods, ¾ in. diam., are also fitted at two places under the frame.

Some of these cars have wrought iron bogie centres or bolsters, a cross section of which is shown. At one end and on one side only cast iron floor joists are used in connection with the Safety Car Heating and Lighting Co.'s steam jackets between the sills at the heater room end.

Pullman Standard 6-Wheeled Bogie.

THE bogie used for these long cars is illustrated by fig. 2. The wheelbase is 10 ft. 6 ins.; the sole bars of the compound or sandwich type, a plate ½ in. thick being bolted on each side of the timber, which is 3¾ ins. thick. The head stocks have a plate ⅜ in. thick on the outside only. The sole bars are secured to the head stocks and cross bearers by flanged castings. The bogie centre rests on a transverse beam, which is supported by and connected to the two bolsters by two diamond bar frames of 4 ins. × 1½ins. iron, and the ends of the bolsters are tied together by arched bars 4 ins. × 2 ins.

The usual equalising beam is used, with double coiled springs between them and the sole bars.

The bolsters are 7 ins. deep × 9½ ins. wide and are built up of two plates ¾ in. thick, one plate ⅜ in. thick, and three slabs of timber 5 ins., 1½ ins., and 1⅛ ins. respectively, all sandwiched together as shown on the drawings.

The Reconstruction of Moncreiffe Tunnel.*

MONCREIFFE TUNNEL, on the Caledonian R., near Perth, is 1,218 yards in length, of which, before reconstruction, 842 yards were lined with brickwork and 376 yards were unlined. The reconstruction was necessitated by the deterioration of the brickwork of the lined portions since the tunnel was built in 1848, and the disintegration of the rock at some of the unlined portions, resulting in pieces falling on to the rails.

The reconstructed tunnel has 1,083 yards lined with brickwork, the remaining 135 yards being unlined. Advantage has also been taken of the reconstruction to enlarge the internal section of the tunnel, and to raise the rails so as to give room for more ballast between the bottom of the sleepers and the rock formation. The new section has vertical side walls and a segmental

*Abstract of a paper by Mr. D. McLellan, read before the Institution of Civil Engineers, February, 1905.

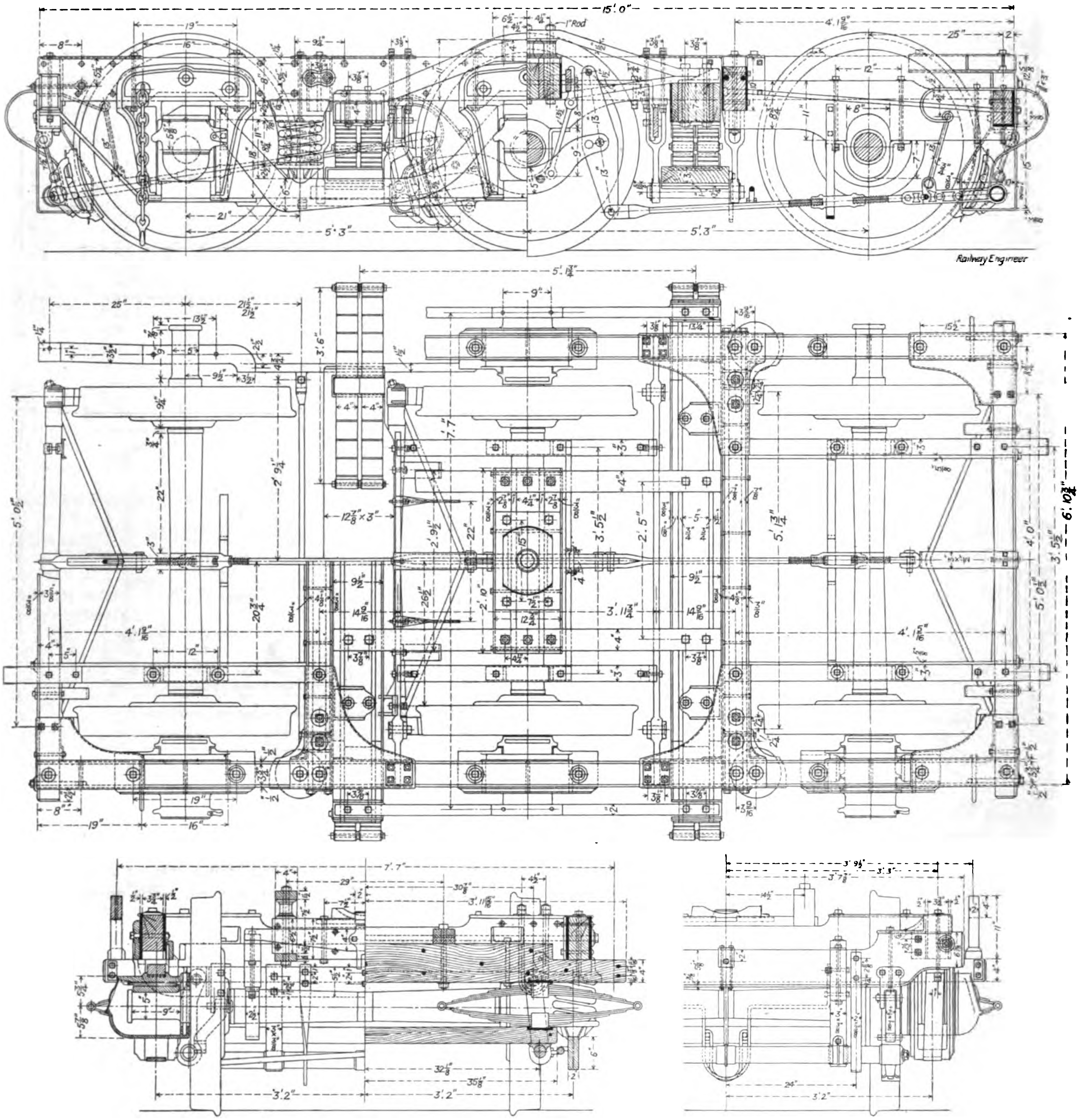


Fig. 2.—Pullman Standard 6-wheeled Bogie.

arch, and admits of the passage of the largest west-coast joint stock with open doors. The minimum thickness of the side walls is 9 ins. and that of the arches 18 ins., the average thicknesses being 1·66 ft. and 2·06 ft. respectively. The lining is faced with blue brindle bricks.

The water in the surrounding ground, which finds its way to the brickwork lining of the tunnel, flows down the extrados of the arch into channels leading to chimney drains built in the side walls. It escapes from the chimney drains through fire-clay pipes built in the walls, and flows to either end of the tunnel through larger fireclay pipes laid on the formation close against the side walls.

The temporary works were situated at the north end of the tunnel, the chief of them being a protective overhead platform, a cement-shed, a 3-ton derrick crane, and electric-light and air plant. The overhead platform, besides being a convenience in dealing with the excavated and building materials, served to protect the traffic on the railway from the jib of the crane when in use. The cement-shed was capable of holding 100 tons of cement. The electric-lighting and air plant supplied light for the whole tunnel during the operations, and fresh air for the workmen, who, without it, would not have been able to remain in the tunnel for a reasonable time, owing to the presence of smoke emitted by engines passing through.

While the reconstruction was in progress the traffic was worked on a single line of rails laid in the centre of the tunnel. The actual work of reconstruction inside the tunnel was carried on with the aid of four steel travelling shields, the principal dimensions of which were 32 ft. long, 22 ft. wide and 16 ft. 8 ins. high. There were openings through the shields, 13 ft. 8 ins. wide and 13 ft. 6 ins. high, for the passage of the trains. These openings were lined with timber, which served as a protection both for the traffic on the railway and for the workmen engaged on the top of the shield. Each shield consisted of two parts, which were connected rigidly together with bolts, and which could be taken apart if necessary. Small trolleys, running on narrow-gauge lines, conveyed the excavated and building materials between the base of operations at the north end of the tunnel and the shields. They were assisted on Sundays, during the cessation of ordinary traffic, by wagons on the running-line.

The reconstruction of an originally unlined portion of tunnel was comparatively simple, owing to the ground being rock. The shields merely acted as a protection, and were scarcely ever required to carry any load other than the weight of the workmen and of the building materials. The side walls were built clear of the shields, and ordinary tunnel centres were used for the building of the arch.

In the reconstruction of an originally lined portion of tunnel in soft ground the old brick lining was supported off the leading end of the shield. A top heading was driven over the extrados of the old arch to allow of the two centre crown bars being drawn. The old arch was removed, commencing at the crown, and the length was timbered as in ordinary tunnelling, the bars being supported at their back end off the new brick arch and at their front end off one of the ribs of the leading half of the shield. When a 12ft. length was completely excavated and timbered the rear half of the shield was detached and moved back to the last length, to be used as a scaffold in connection with the removal of the timber centres. While the two portions of the shield were apart the opportunity was taken of building the side walls. Then the rear half of the shield was moved forward with the centres, which were erected in their new position, and another length of brick arch was built.

Alarm bells connected with the signal-boxes outside were provided at seven different points in the tunnel, and there was also telephonic communication between the middle of the tunnel and the same signal-boxes. The drivers of engines were instructed to prevent as far as possible the emission of smoke and steam when passing through the tunnel, and to sound their whistles.

The time taken to complete a 12-foot length of originally unlined tunnel was seven days. The corresponding time for a 12-foot length of originally lined tunnel in soft ground was eleven days, and for a 12-foot length of originally lined tunnel in rock eight days. The average progress was 15 lineal yards per month per shield, the best progress of any one shield being 18 lineal yards per month.

The operations were carried on continuously, working night and day and on Sundays. There were three 8-hour shifts of miners in the 24 hours, and one shift of bricklayers, the number of men employed daily being 150. The reconstruction work proper inside the tunnel was commenced on the 27th January, 1902, and was completed on the 25th December, 1903. Single-line working through the tunnel was brought into operation on the 1st December, 1901, and double-line working was resumed on the 6th March, 1904.

The work was carried out by the Caledonian R. Company under the direction of Mr. Donald A. Matheson, M. Inst. C.E., assisted by the author, Mr. W. A. Kemp acting as resident engineer.

Features of Continental Goods Engines.

(Continued from page 78.)

The Southern R. of France has recently put into service an exceptionally fine class of goods engines, illustrated by fig. 5. They are the latest development of the well-known de Glehn four-cylinder compound system. The two high pressure cylinders, 15·35 ins by 26·37 ins., are underneath the smokebox and between the frames driving the second coupled axle; they are inclined at 1 in 8 from horizontal in order to clear the leading axle; the low pressure cylinders, 23·67 ins. by 26·37 ins., drive on to the third coupled axle. The difference in the lengths of connecting rods is striking, the high pressure rods being 6 ft. 2 ins. and the low pressure rods 9 ft. 10·06 ins. long between the centres, but as the engine is only intended for low speeds, this is not a harmful feature. The high pressure valve gear is Stephenson's link, while that for the low pressure cylinders is Walschaërt's. Placed between and above the high pressure cylinders is the valve controlling the various combinations of workings, namely, full compound, semi-compound, and simple. With ample steaming capacity, this system of varying the working of the engine is commendable, as it places in the hands of the driver a large reserve power, available when required; the valve is actuated by a compressed air cylinder; a quarter turn suffices to convert the engines from a compound to a four-cylinder simple.

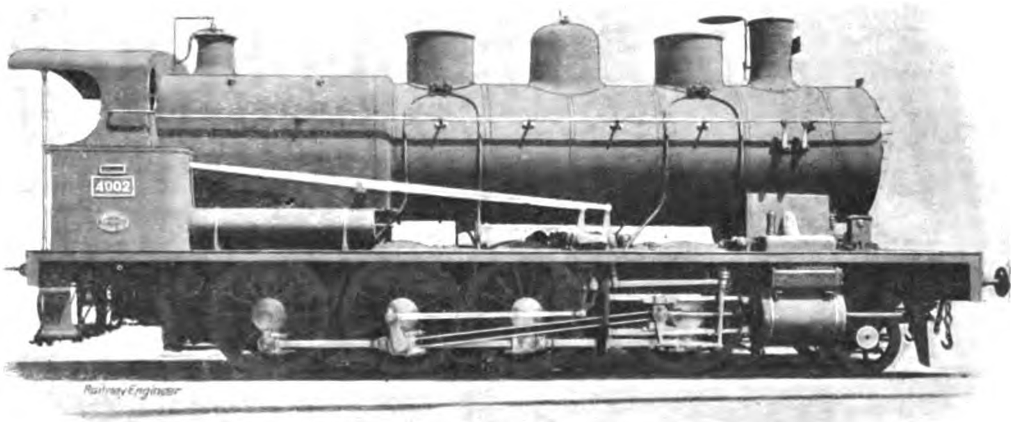


Fig. 5.

Fig. 6.

From the illustration, fig. 5, an idea can be formed of the boiler dimensions; the barrel is 4 ft. 11·56 ins. diam. by 14 ft. 1·26 ins. long between the tube plates; it contains 148 Serve tubes; the firebox shell is 9 ft. 10 ins. by 3 ft. 11·8 ins. wide outside; the inside firebox is 3 ft. 3·38 ins. wide. The total heating surface is 2,757·35 sq. ft.; the working pressure 213 lbs. per sq inch. For such a large engine the wheelbase, 23 ft. 1·56 ins., of which 16 ft 0·9 ins. is rigid, is rather short; the frames, 1·18 ins. thick, are 4 ft. 1·21 ins. apart, and are stayed very rigidly. The weight in working order is 70 tons 9 cwts.; the adhesive weight of 63 tons 11 cwts. is very equally distributed, leaving 6 tons 18 cwts. at the truck wheels.

Another very powerful engine, the 4-8-0 type, illustrated by fig. 6, was built by Ansaldo and Co. for the Mediterranean R. of Italy. It is a two-cylinder compound with a receiver between the cylinders and a special automatic valve to permit boiler steam to pass to the low pressure cylinder, when the engine is in full gear, at the same time allowing a free passage of the exhaust steam to the blast pipe. The cylinders are 21·26 ins. and 31·5 ins. by 26·77 ins.; centre to centre of the cylinders is 6 ft. 8·08 in., and owing to the large dimensions of the cylinders the frames have to be inset at this point to 3 ft. 2·9 ins. between, as against 4 ft. ·02 ins. elsewhere; the high pressure valve is of the piston type, while a balanced slide valve is used for low pressure; Walschaërt's gear is fitted; both cylinders are fitted with relief valves on each cover and also with anti-vacuum valves.

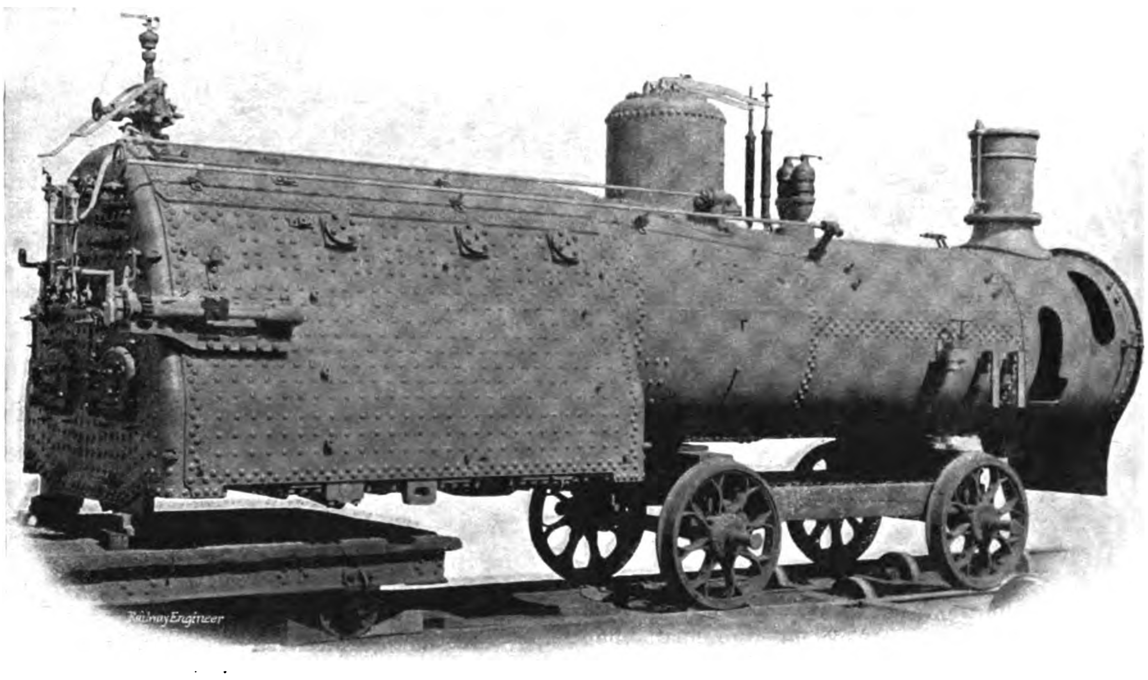


Fig. 7.—Boiler for Engine illustrated by Fig. 6.

The bogie is of the swing link type with a spherical centre, any rolling that might set up being controlled by vertical springs. Each axlebox has an independent, plate spring; the bogie wheels are 2 ft. 9·07 ins. diam., with a wheelbase of 6 ft. 6·75 ins. The total wheelbase of the engine is 26 ft. 1·39 ins., the coupled wheelbase being 14 ft. 11·5 ins.

In the boiler design lie the chief points of interest. The

Railway.										
Cylinders H.P.	18·5	[illegible]5		[illegible]						
Cylinders L.P.	—	29·53"	21·26							
,, Stroke...	25·59"	24·8"	23·62"	25·2"	24·0					
Wheels arrangement	0-6-0	2-6-0	2-6-0	0-8-0	0-8-0	2-8-0	2-8-0			
Coupled Wheels, diam. ...	4'-7·9"	4'-5·14"	4'-11·83"	4'-7·13"	4'-1"	3'-10·06	4'-1·5"	4'-7·13"	4'-7[illegible]	—
Wheelbase—Total	13'-10·14"	19'-8·22"	20'-8·42"	25'-5·5"	14'-9·13"	22'-11·59"	22'-3·73"	23'-1·5"	26'-1·39"	19'-2·5"
,, Coupled	,,	—	12'-9·5"	,,	,,	—	14'-1·3"	16'-0·9"	14'-11·52"	,,
,, Rigid	,,	5'-3·95"	,,	—	,,	9'-2·24"	14'-1·3"	,,	,,	,,
Boiler Pressure—Lbs. ...	—	172	205	213	172	172	199	213	205	199
Heating Surface, sq. ft.—										
Tubes ...	1,282·3	1,470·00	1,377·8	2,063·0	1,395·0	1,812·0	2,539·4	2,587·52	1,586·55	—
Firebox...	126·26	107·64	132·4	120·0	113·0	125·5	150·6	170·83	147·47	—
Total ...	1,408·56	1,577·64	1,511·2	2,183·0	1,508·0	1,937·5	2,690·0	2,758·35	1,734·12	2283·0
Grate Area ...	27·88	24·22	24·76	22·6	23·7	26·0	36·1	30·14	47·36	32·28
Weight, maximum, in working order—										
Tons, Cwts., Qrs. ...	47-6-2	43-0-0	53-18-0	52-0-0	52-0-0	63-11-0	67-8-0	70-9-0	73-6-3	64-13-0
Bogie ...	—	7-13-0	10-2-0	—	—	19-17-0	11-5-3	6-18-0	18-10-0	—
Adhesive ...	—	32-7-0	43-16-0	2-0-0	,,	53-14-0	56-2-1	63-11-0	54-16-3	64-13-0

firebox is of radial stayed or modified Wootten type, without a combustion chamber in the barrel, this being formed by building up a brick arch at some distance from the tube plate. This is the first instance of this type of boiler in Continental practice, although the wide fireboxes on the Belgian State engines are more or less in this form. The barrel is built in two rings, of which the one next the firebox is conical, the diameters being 5 ft. 6 ins. and 5 ft. 6·5 ins.; there are 280 tubes, 1·96 ins. diam., 12 ft. 9 ins. long between the tube plates; the firebox shell is 8 ft. 2·24 ins. long, 6 ft. 8·47 ins. wide, and 4ft. 3·7 ins. deep at the front and 4 ft. 1·9 ins. at the back; the grate area is 47·36 sq. ft., the heating surface of the firebox is 147·4 sq. ft., and of tubes 1,586·65 sq. ft.; the working pressure is 199 lbs. per sq. inch. The weight is 73 tons 6 cwts. 3 qrs., of which 54 tons 16 cwts. 3 qrs. are adhesive.

Engines of the 0-10-0 type are not common on any railway, particularly in Europe, although there are some of them in the Caucasus and on the Austrian State R. The former, not being European built, are not described in this article, which only deals with engines of this origin. The latter are very large engines; all the wheels are coupled, and as the service they are built for is heavy mineral traffic the wheels are not large, viz., 4 ft. 3 ins. diam.; the wheelbase is 19 ft. 2·5 ins., the third and fifth axles being allowed an inch side play. The two cylinders, which are compounded on the Golsdorf system and drive on to the fourth axle, are 22·05 ins. and 33·46 ins diam. by 24·88 ins. The boiler pressure is 199 lbs. per sq. inch; the heating surface 2,285 sq. ft.; the grate area is 32.28 sq. ft., which is needed to burn the very low quality fuel. In working order the weight is 64 tons 13 cwts.

The table gives at a glance the principal dimensions of the various engines above mentioned.

Electrically Operated Carriages; Metropolitan Railway.

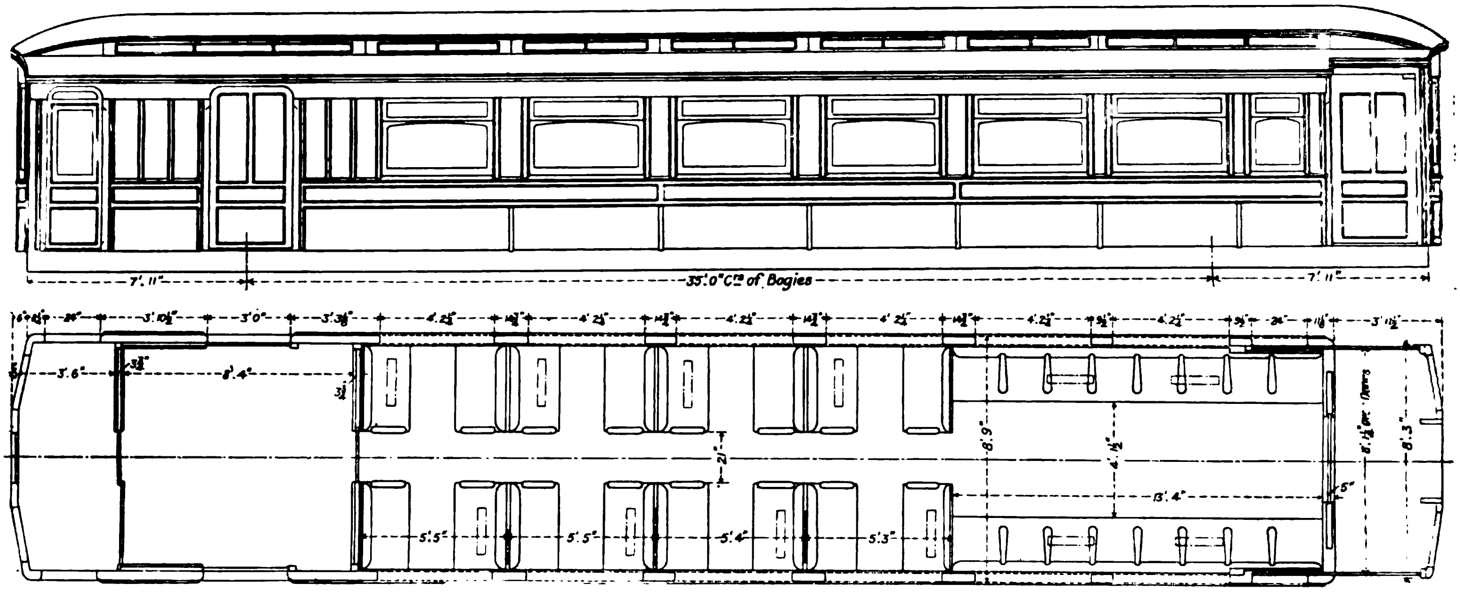
All the new rolling stock designed in connection with the electrification of the Metropolitan R. has been built at one or other of the works of the Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd., of Saltley, Birmingham, and we are indebted to Mr. A. Ingram, the carriage and wagon superintendent of the railway company, for the drawings and photographs from which our illustrations have been made and also for showing us the carriages and supplying us with the particulars embodied in the following description of their most interesting features.

These carriages, which were all built under the immediate supervision of Mr. Ingram, are a very fine job, and it is a matter of satisfaction to know that they were all "made in England."

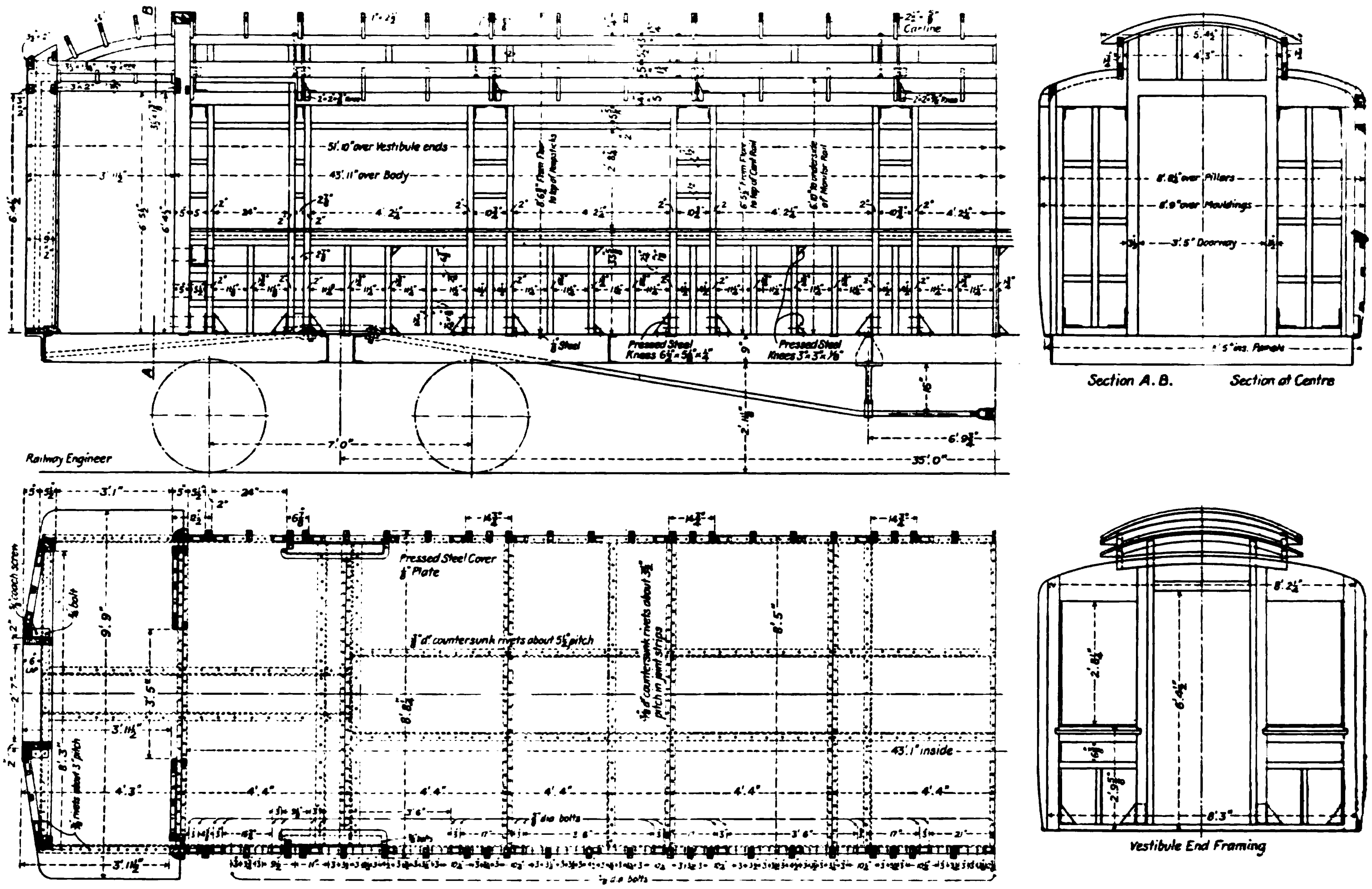
So far as the construction of the bodies and the underframes is concerned the two types of carriages (viz., motor and trailer carriages) do not differ very materially from each other.

The motor carriages are third class, and the trailer carriages first and third class.

The arrangement of the seats is that usually adopted for



Electrically Operated Carriages, Metropolitan Railway.—Motor Car.



Electrically Operated Carriages, Metropolitan Railway.—Body Framing of Trailer Car.

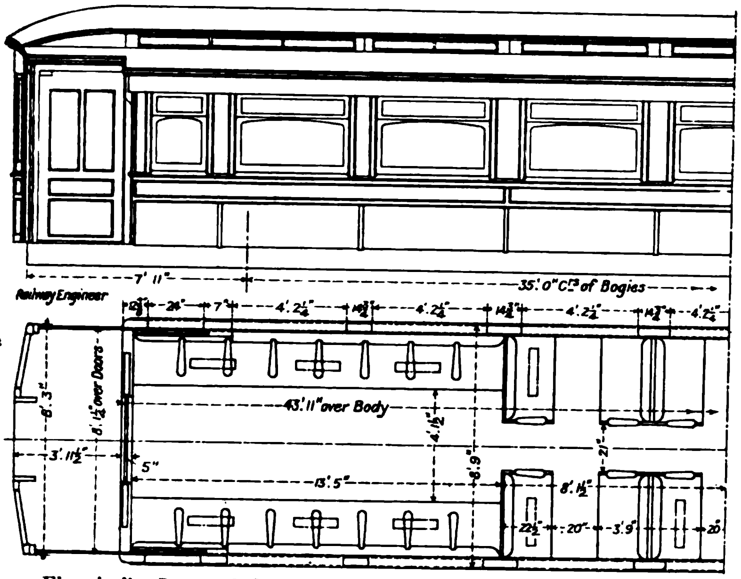
carriages of electric railways, that is, cross seats in the centre and longitudinal seats at ends. The advantages of this arrangement are that the trap-doors in the floor for examining the electric gear are more conveniently got at, and there is larger standing room for passengers.

The motor carriages seat 49 passengers, and the trailer carriages 56 passengers.

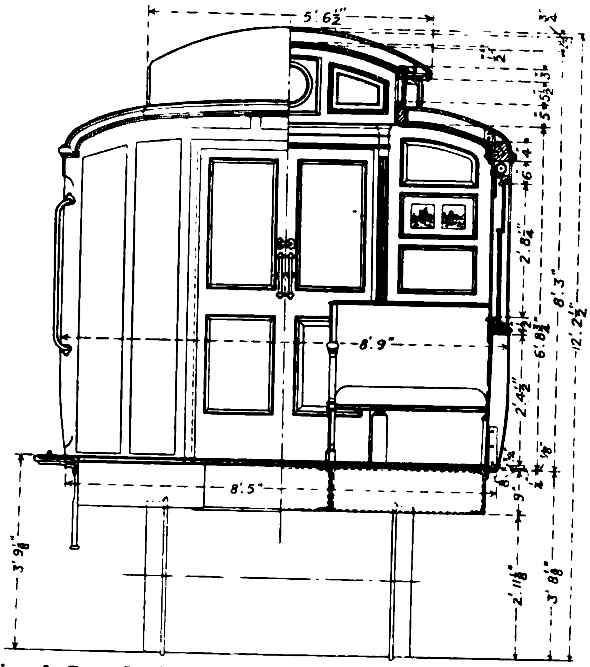
The principal dimensions of all the carriages are :—

Length over headstock	50 ft. 10 ins.
Centre to centre of bogies	35 ft. 0 ins.
Wheel base of bogies	7 ,, 0 ,,
Width of waist (with 2 ins. turn-under at each side)	8 ,, 9 ,,
Height at sides to top of cant-rail from top of solebars	6 ,, 5¼ ,,
Height from rail	10 ,, 1¾ ,,
Height from rail to top of monitor roof ...	12 ,, 3¾ ,,

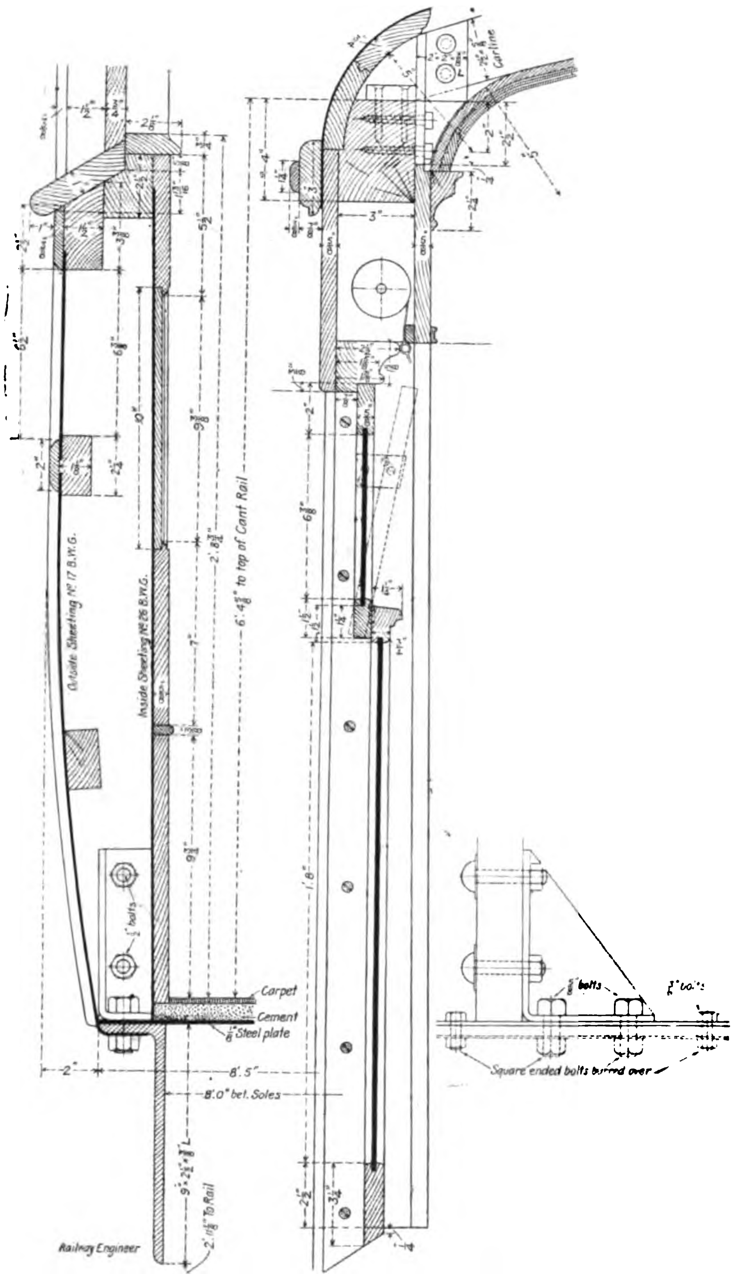
The construction of the body framing is shown on the



Electrically Operated Carriages, Metropolitan Railway.—Trailer Car.



End View & Cross Section of Motor & Trailer Cars, Metropolitan Railway.



Section of Side of Trailer Car.
Electrically Operated Carriages, Metropolitan Railway.

drawings. The side pillars stand on the steel floor and are secured to the flange of the solebar by means of pressed steel brackets and the waist panel is fastened to them with countersunk screws. The junction between the side pillars and the cant-rail is also made with pressed steel brackets.

The floor consists of steel plates, ⅛ in. thick, covered with George Powell's Patent Paris Cement, ⅞ in. thick, and carpets treated to render same non-flammable.

The outside panel below the light rail consists of sheet steel $\frac{1}{16}$ in. thick, turned under the edge of the floor plate, and rivetted to an angle which is bolted to the solebar. The panel is grained teak, and gives a particularly light and neat finish to the sides of the carriages.

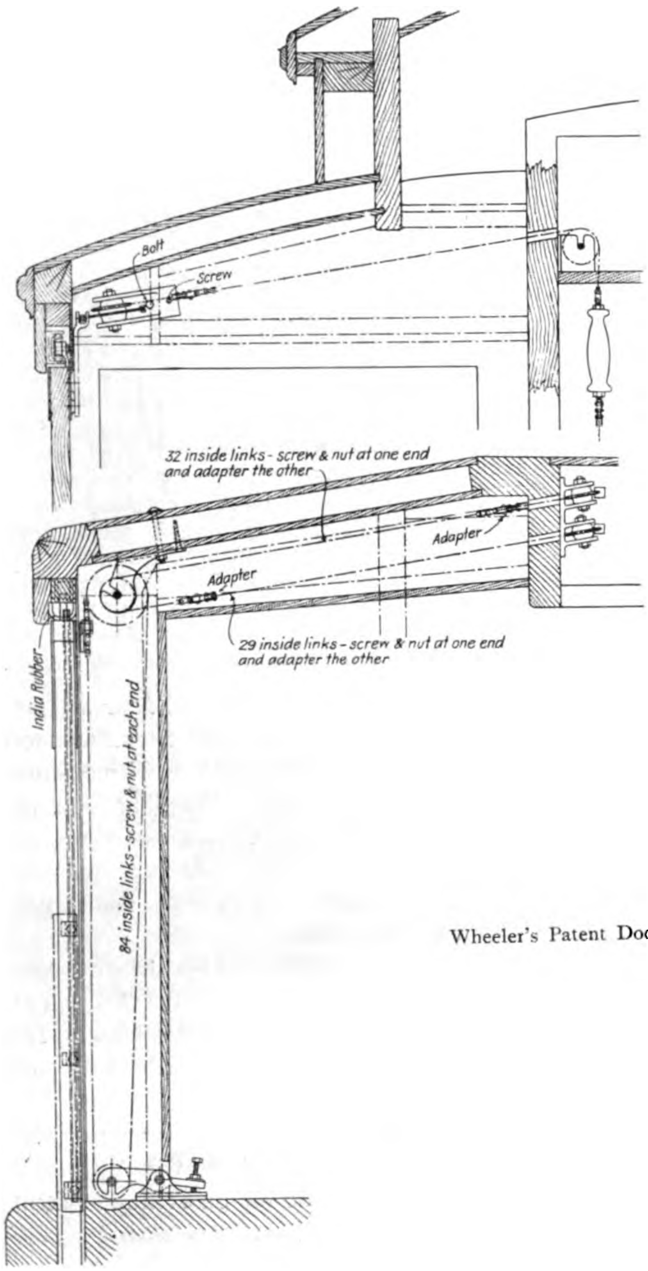
The entrance doors are of the double sliding type, with glazed upper panels of neat design embodying the Company's monogram. They are hung from the top on Crittall's patent ball runner, and move with little noise. The doorways are 3 ft. 5 ins. wide, and the doors when open give 3 ft. clearance, which renders side doors unnecessary. The doors meet in the middle with a V joint, which excludes the draught, and prevents them rattling.

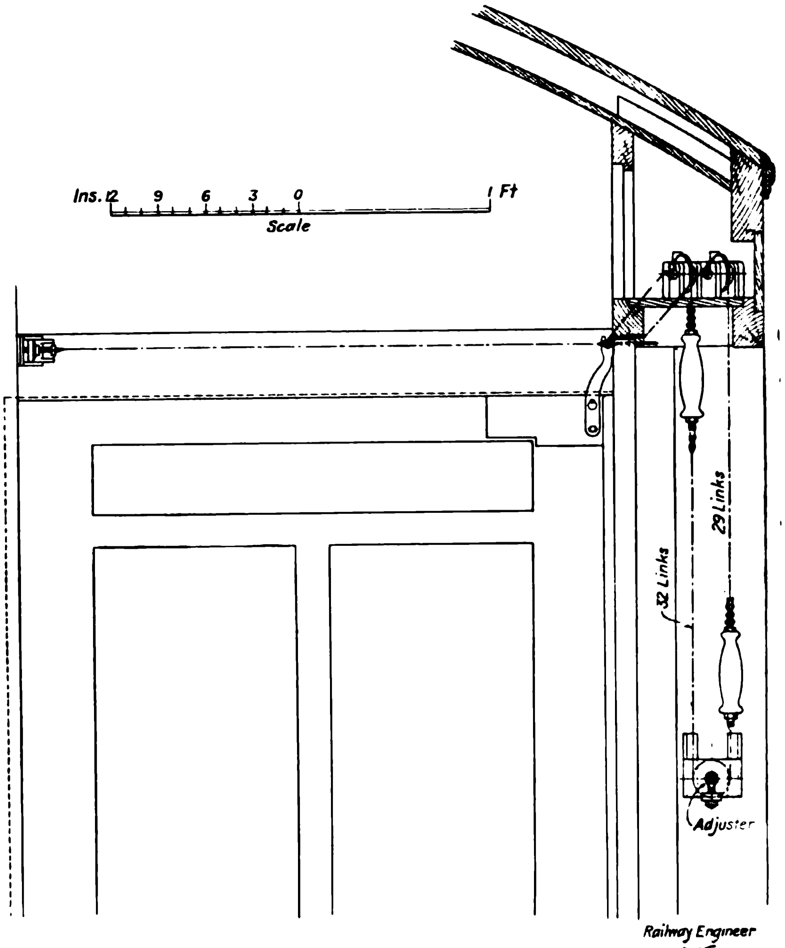
All woodwork used is of well-seasoned Burmah teak of the best quality.

A continuous stepboard constructed of pressed steel is fixed on each side of the carriage at a height which allows of it overlapping the station platform, thus preventing accidents by passengers stepping between platform and carriage.

The entrance platforms are vestibuled upon quite a novel plan. The iron gates with which tube-railway carriages have been fitted have been abolished. They have disadvantages in our climate when carriages work "in the open," and their opening inwards is a drawback when the platform is crowded with passengers.

It will be seen from our drawings that the entrance platfrom is enclosed and fitted with Wheeler's patent sliding doors, of which we give a detail drawing. These doors are hung from the top on Crittall's ball bearing and are worked





Wheeler's Patent Door Operating Gear.—Electrically Operated Carriages, Metropolitan Railway.

by sprocket wheels and chains. The trainman stands in the gangway between the carriages and pulls down the handles and the doors of the adjacent carriages roll back into recesses in the sides.

The gangways are provided with glazed doors which fold back neatly out of the way when the gangway is open. By these arrangements the platforms may at all times be occupied by passengers with safety and comfort, whereas the open platform in a tube or "in the open" is, from our experiences, anything but a pleasant place to travel on.

The underframes are constructed of Siemens-Martin steel channels and angles and the bogies of pressed steel plates. Drawings of these will be given in our next issue.

The electrical equipment is supplied by the British Westinghouse Electric and Manufacturing Company.

Each motor carriage is fitted with four motors, which are spring suspended, and entirely independent of the carriage springs; the weight being carried on the solebars having no connection with the truck. Each motor has a normal rating

Morgan's Patent Pressed Steel Seat.
Electrically Operated Carriages, Metropolitan Railway.

of 150 h.p., and is operated by means of the Westinghouse system of electro-pneumatic control. The equipment of two of these carriages is capable of operating a six-coach train weighing 150 tons. The controllers are actuated by compressed air, which in turn is governed by a series of electro-magnets, current for which is supplied from accumulators carried in the luggage compartment of motor carriages.

There are no high tension cables carried underneath any

of the trailer carriages; but low voltage controller connections (which run the whole length of train) are carefully laid in asbestos casing, and firmly fixed to steel floor, thus obviating all danger of fire.

The interior finish of the carriages leaves nothing to be desired. The ceilings are of asbestos, relieved by artistic mouldings. The inside panels are of wainscot oak or (in the first class carriages) walnut and light oak.

The seat supports and ends are of an entirely new type, each consisting of one piece of highly finished pressed oxidised steel, embossed with the Company's registered design on the ends, the legs being of Elizabethan form. These seats are Morgan's Patent Pressed Steel Seats, and our illustration of one of them gives a good idea of their handsome appearance.

The seats and backs (supplied by the " Hammock " Spring Seats Company) are of flat steel.

The first class non-smokers are upholstered in art coloured moquette, and the smokers in green buffalo leather. The third class carriages are also upholstered in buffalo leather.

All upholstery has undergone special treatment to render it non-flammable.

All the carriages are fitted with W. S. Laycock's spring roller blinds and electric heaters.

The side lights of the monitor roof are glazed in muffled glass, and are all hinged at one end, and fitted with a toggle joint attached to brass sliding bars half the length of the carriage, so that half of the windows on either side may be open to suit the direction in which the vehicle is travelling. The operating levers are at the ends of the carriage.

Each carriage is lighted with thirty 32 c.p. incandescent lamps hung from handsome bronzed fittings.

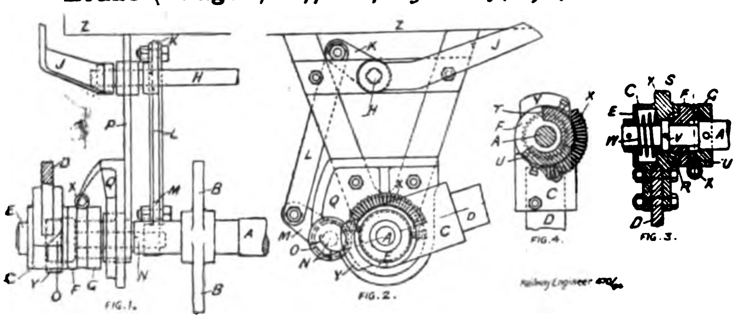
An emergency oil lamp is fitted at each end of carriage, and is so arranged as to illuminate interior of carriage and platform.

It will be seen that great care has been taken to minimise the risk of fire, even the window blinds being of non-flammable material.

Recent Patents relating to Railways.

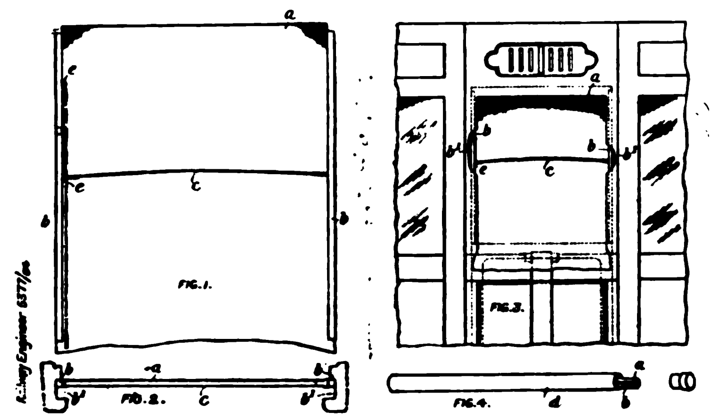
These abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d*. each.

Brake (Wagon). *470. 7th January, 1904. T. Greaves,*



24, Hood Square, Winlaton, and T. Rippeth, Strathmore Road, Rowlands Gill, Durham.
This invention relates to means for adjusting brake mechanism to compensate for the wear of the brake blocks. A box C, provided with a toothed flange R, is mounted loosely on the brake shaft and connected to the hand lever D. Loose and fast clutch rings F, G are also mounted on the brake shaft adjacent to the box, each being provided with a lug or tooth T, U engaging with each other in such a manner that the loose ring can turn a certain distance relatively to the fast ring. When the brake lever D is depressed the lug T on the loose clutch ring F bears against the lug U of the fast ring G, and is kept in this normal position by a spiral spring X on the periphery, which connects the two lugs together. An auxiliary shaft H extending across the wagon, and having a hand lever J on each end, is connected with a short shaft N provided at each end with a cam O adapted to throw the box and lever D out of gear with the loose clutch ring. With this invention a man can actuate the brakes from either side of the wagon. With the exception of the addition of the invention to the main weigh shaft A the brake mechanism may be arranged as at present. When the brake blocks wear and the range of the hand levers is insufficient to put on the brakes the mechanism is adjusted to compensate for such wear in the following manner. The brake hand lever D is lifted, thus separating the faces of the lugs T and U on the fast and loose clutch rings F and G and at the same time extending the spring X connecting the two lugs together. A side or outward pull on the box C by lifting lever J compresses the spring W therein, releases the box from the loose clutch ring F, and the spring X at once brings the lugs of the two clutch rings together again. The brake lever D is now free, and must be lifted until the teeth of the box C have moved round a distance equal to the pitch. If the box C be now released the teeth will re-engage with the teeth of the loose clutch F owing to the pressure of the spring W, the pitch of the teeth being such that the lever D must be lifted from the bottom nearly to the top of the sector before the parts C and F will re-engage. The lever D thus assumes a new position in which the brake may be applied. (*Accepted 5th January, 1905.*)

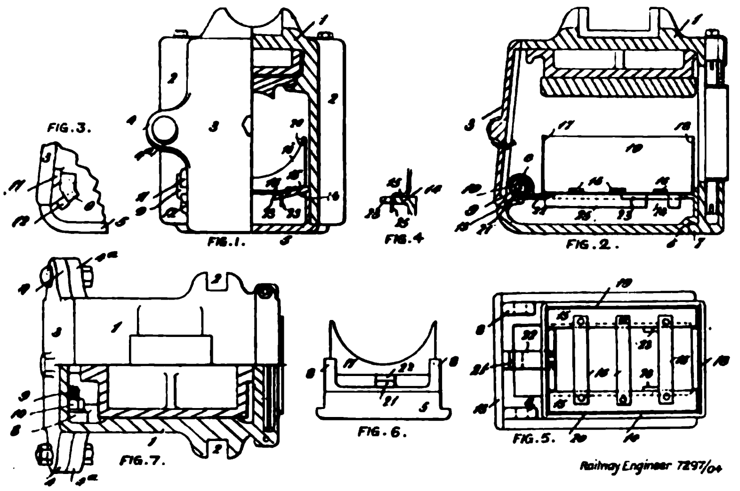
Dust Screen for Windows. *5,377. 4th March, 1904. W. McLaren, Moorgate Works, Moorfields, London.*
The screen consists of a piece of cheese cloth, muslin or other suitable fabric of approximately the size of the window opening, the opposite sides of which are attached to laths, preferably of wood. These laths are placed in the window rims or recesses of the framing on either side of the window opening, and are held in position there by a transverse lath of wood or metal which is



sprung in between them, the transverse lath being advantageously hinged at one extremity to one of the side laths. To accommodate the screen to the varying widths of window openings, the fabric may be rolled round the lateral lath to which the hinged transverse lath is not attached; and for carrying about, when not in use, the screen may be completely rolled up. To facilitate the folding the transverse lath can be jointed so that it can lie completely within the length of the side laths. (*Accepted, 5th January, 1905.*)

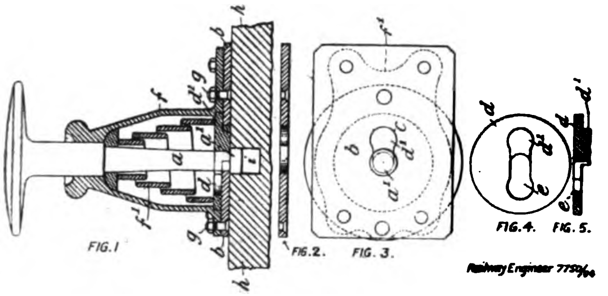
Axle Boxes. *7,297. 26th March, 1904. W. S. Laycock, Victoria Works, Millhouses, Sheffield.*
This invention has reference to axle boxes adapted to contain oil for lubrication, and packing material for conveying the oil to the

journal, its object being to provide a separate and easily removable receptacle—17, 18, 19, 20—for the packing, which is attached to a movable oil well 5, arranged to form the bottom of the axle box. Flanges 14 are formed on the oil well, which prevent the oil from splashing or running out of the box, and also facilitate the return of any excess of oil from the packing box. The packing box has flanges 15, which rest upon the flanges 14 of the oil well, and bridge pieces 16 forming a support for the packing or lubricating pad which dips into the oil well. The box is secured in position in front by means of the projection 21, which engages a spring tongue 22, whilst at its sides the box is secured by the projections 23, which engage L shaped slots 24



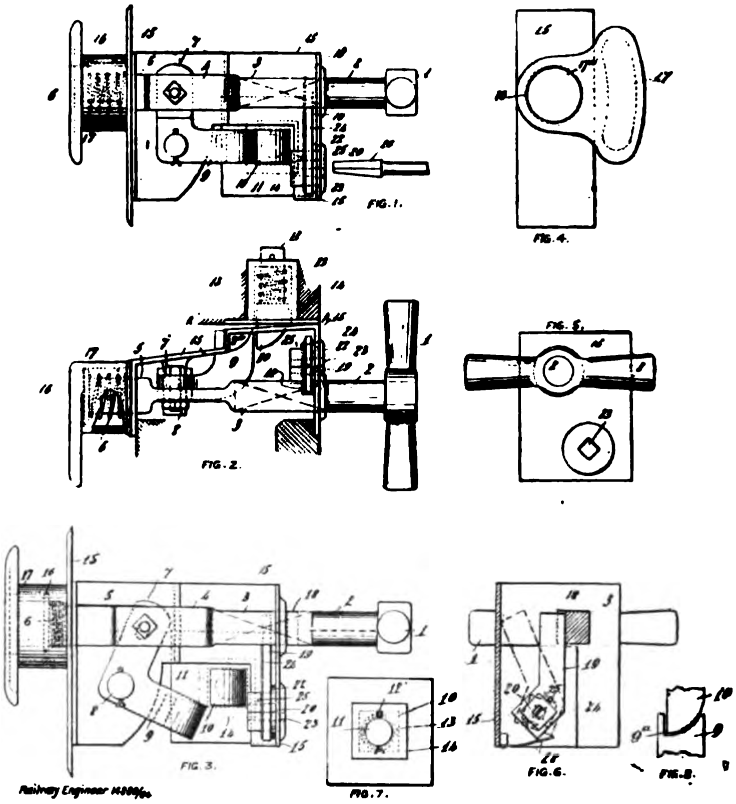
formed in the extensions 25, upon the flanges 15. The box is removed by raising the tongue until clear of the projection 21, when the box is pulled forwards to enable the projection 23 to be freed from the engaging slots 24. In practice, assuming it is desired to remove the well, the cover 3 is first removed, then the nuts 10 are removed, the bolts 9 withdrawn, when the front of the well is lowered a slight foward movement entirely frees it from the axle box. The disposition of the horn guides or bearings to and the arrangement of the oil well is such that the removal or replacement of the oil well is readily affected without the removal of axle guard bridle, and, further, the maximum length of horn bearing is obtained without the necessity of forming a continuation of the guard upon the oil well. (*Accepted 26th January, 1905.*)

Buffers. *7,750. 2nd April, 1904. G. T. Heald, 181, Cathedral Road; W. Wentworth, 1, Morlais Street, Roath Park, Cardiff; and D. W. Rees, "The Aucklands," Doncaster.*
The plunger a has a comparatively small head a^1 arranged to bear against an outer back plate b, which has a slot c of such shape that the head a^1 on the rear end of the plunger a can be passed



through the slot c, and the plunger a then slid laterally or sideways in the slot c, thus bringing the head a^1 behind a narrowed part of the slot, through which it cannot pass. In front of the outer back plate b is an inner back plate d, which is slotted at e in agreement with the slot c in the outer back plate b. The inner back plate d has formed on it a snug d^1, which projects back from the rear face of the plate. The plate d is placed on the plunger a before the plate b, and after the latter has been put on the plunger a is moved laterally into final position. The plate d is then moved into such position that the snug d^1 can be passed backwards into the slot c in the outer back plate b. The plates b and d become thus interlocked, and they are maintained so by the plunger a. With this construction the recess or cavity i in the headstock h is not so large in diameter as that needed to accommodate the nut hitherto employed to hold the plunger in place. (*Accepted January 26th, 1905.*)

Carriage Door Fastenings. *14,880. 2nd July, 1904. L. H. Mackay, 11, Western Hill, Durham.*
To the door or other part to be latched or fastened is secured a casing 15 within which slides a rod or bar 2, 3, 4, 5, so shaped towards one end that the inner portion 5 may project beyond the inner line of the door and at its extremity carry a button or plate 16. The protruding end 5 of the rod between the button 16 and the face of the door is encircled by a spiral spring 6. The parts are enclosed by the hollow handle 17. The end 2 of the actuating rod which protrudes from the casing 15 and the outside of the door has mounted on it a tee or other suitable handle 1. On the rod somewhat towards its spring controlled end 5 is centred one arm 7 of a bell cranked lever mounted at the bend or intersection of the arms on a fixed centre or stud 8 carried by the casing 15, whilst by its other arm 9 this bell cranked arm is adapted for latching purposes to engage a bevelled nose piece, or latch-bolt 10 mounted on a stem 11 capable of sliding in a bearing formed in the wall of a casing 14 screwed to the jamb of the doorway, and adapted to

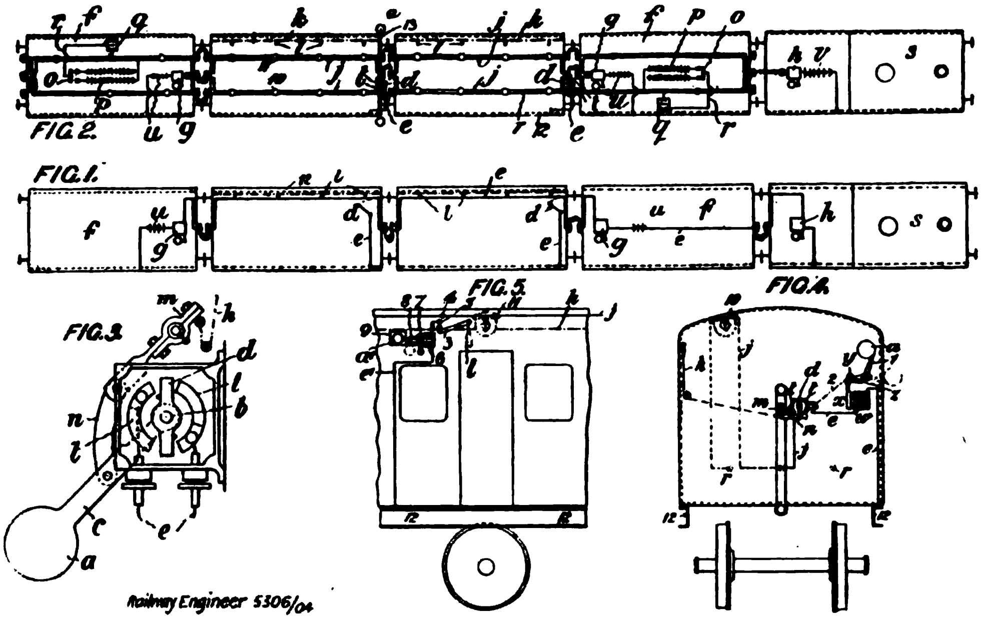


receive the nose piece 10 and stem 11 and a spiral encircling spring 13. A cross pin 12 through the inner end of nose piece stem 11 serves to keep the parts in place. Normally the actuating handle 1 and stem 2 or rod are drawn inwards by their spring 6, and the bell crank lever 7—9, is swung on its centre 8, so that the one arm 7 is drawn back and the other arm 9 is moved so as to bring it into locking engagement by its abutting against whilst lying within the nose piece 10 projecting from the jamb. The nose piece 10 is normally kept protruding by the resilience of its controlling spring 13 being caused to recede within its casing as the door closes. To open the door when closed and locked a pull is exerted upon the handle 1 on the end of the actuating rod 2—5, which then comes forward against the pressure of the coiled spring 6, and by reason of its connection at 8 to the bell crank lever arm 7, the other arm 9 is rocked clear of the nose-piece and door is free to open; except when the rotatory stop-piece 19 is rocked on its centre 20 into

engagement with the slot 18, by a railway or other like key one end of which is shown at 26. (*Accepted 26th January, 1905.*)

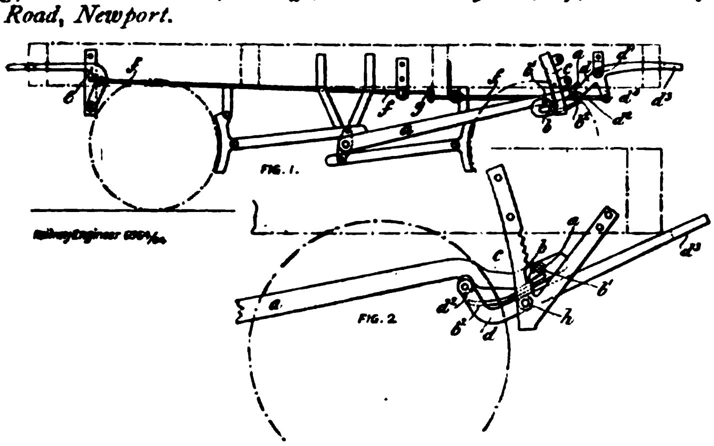
Inter-Communication on Trains. *5,306. 3rd March, 1904. E. M. Preston, of the firm of J. Stone and Co, Deptford, Kent, and A. F. Rock, Denholme Villa, Queen's Road, Stoke-upon-Trent, Stafford.*

This invention relates to improvements in apparatus for affording communication between passengers and guards, and for applying the brakes on trains. The communication cord is connected up to operate the vacuum or other brake, and is also adapted to turn a disc (*a*) or other visible signal at the end of each coach or there may be a separate signal for each compartment. The disc is suitably mounted on a rod or shaft (*b*) or 13, which also carries a switch (*d*), which latter on being operated sends a current through a wire (*e*) to one or both of the guards vans and rings a bell (*g*) arranged therein. There may also be a bell or other signal adapted to attract the attention of the engine-driver if desired. If Stone's system of lightning be used, then the negative wire of



the circuit for simultaneously controlling or switching on or off sets of electric lamps may be employed in such manner that, immediately the shaft of the signal is turned, a current passes through the negative wire and rings the bell till the disc has been put into position again by the guard of the train. (*Accepted 5th January, 1905.*)

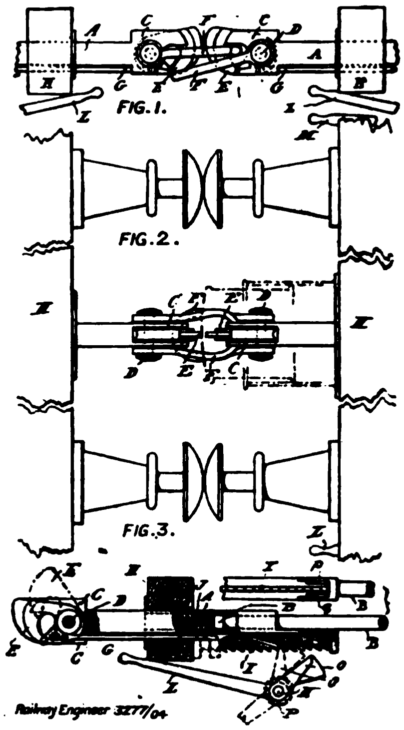
Brakes (Wagon). *6,564. 18th March, 1904. E. Liley, 3, Llanishen Street, Cardiff; and M. F. Jones, 29, Llanthewy Road, Newport.*



According to this invention the side lever (*a*) has a pawl (*b*) pivotted at its end engaging with a curved rack (*c*) fixed to the side of the vehicle, the pawl being balanced to keep it in gear with the rack when the lever is moved in an upward direction to put the brake on. A **T** shaped lever (*d*) is pivotted on the side of the vehicle with a loop handle at one end and a friction roller and pin at the other. On pressing down the handle the roller end of the lever is raised and moves the side lever in an upward direction, putting the brakes on and the balanced pawl engaging in the rack holds them in position. At the end of the balanced pawl a tail piece is formed projecting so as to stand underneath the friction roller on the **T** lever (*d*) so that when the handle of the lever is lifted the roller comes in contact with the tail piece of the pawl so disengaging it from the rack and taking the brakes off. An **L** shaped lever is pivotted on the opposite side of the vehicle and connected to the third arm of the **T** lever by rods and bell cranks or traverse shaft so that the brakes may be operated from either side. (*Accepted 19th January, 1905.*)

Couplings (Automatic). *3,277. 10th February, 1904. J. Darling, 8, Jedburgh Avenue, Rutherglen, Lanark; and J. M. Lennie, 65, Minard Road, Crossmyloof, Glasgow.*

A slide A is connected to the ordinary drawbar B, the outer end

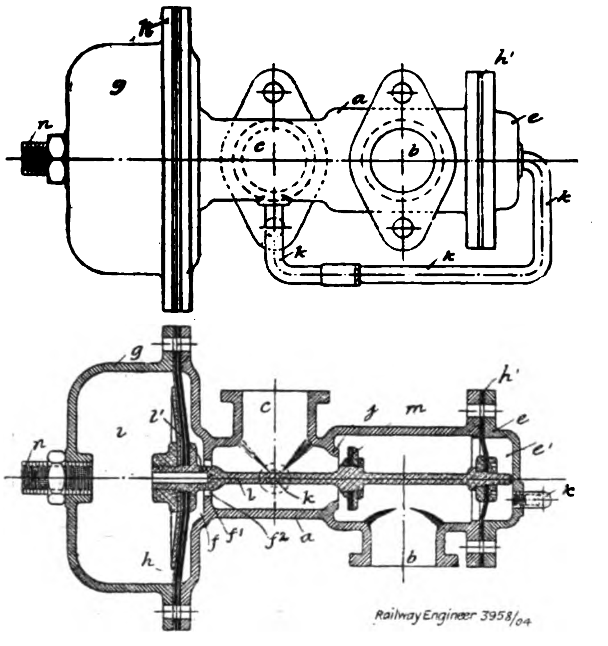


of the slide A terminating in a forked or bifurcated head C, having pivoted therein a hook E. On the outer ends of the pivot D of the hook E a coupling shackle F is mounted, and adapted to engage with the hook of an adjacent vehicle. When two waggons are brought together the coupling link F, which is on the highest level, comes in contact with the hook E, and raises it until it becomes engaged with it and the hook drops down by gravity when the coupling is effected The hook is raised out of engagement with the link by a sliding rod G, which is thrust forward against the action of a spring by a pawl and ratchet device actuated from either side of the vehicle. (*Accepted 12th January, 1905.*)

Vacuum Brakes. *3,958. 17th February, 1904. G. J. Churchward, Newburn, F. W. Snell, 87, Clifton Street, F. H. Rayer, 16, Gordon Road, and C. K. Dumas, 35, Bath Road, all of Swindon, Wilts.*

This invention has reference to improvements in automatic brakes, and has for its object limiting the application of the brake to moderate power when required, by automatically limiting the rapidity of the entrance of atmospheric air into the train pipe on the opening of the driver's valve, within the limits for ordinary application, and also to enable the brake to be applied with extreme rapidity and power by allowing the atmospheric air to enter the train pipe with full rapidity, on a further movement of the driver's, valve or on the opening of a separate

valve, whereby the usual accelerating valves are opened to admit air at or near each brake cylinder. A suitable arrangement for carrying out this invention is to arrange on the pipe leading from the driver's valve an automatic valve the arrangement of this valve being such that in its normal or working position the valve is open, and allows air to pass through it from or to the train pipe. On the driver's valve being opened to admit atmospheric air to apply the brake with moderate power, by destroying, or partially so, the vacuum in the train pipe, the air will pass through the automatic valve until the rapidity increases beyond that to which the valve is set, when the valve will close, or partially so, and remain in that position until the balance of pressure is upset, or the air becomes rarefied in the brake pipe, when the valve will open again automatically, and the atmospheric air admitted though the driver's valve will again pass to the brake pipe. To apply the brake with extreme rapidity and power, atmospheric air may be admitted to the brake pipe, through the automatic valve, with full rapidity, so as to operate the usual accelerating or sensitive quick acting valves for admitting the atmospheric air direct into the brake pipe, at or near the brake cylinders, the valve being kept in its open position by suitable means. A suitable cons-



truction of automatic valve comprises a valve casing *a* connected at *b* and *c* to the driver's valve and brake pipe respectively. The lower end of the casing has a cover *e* attached, having an internal recess e^1, the upper end of the casing is enlarged, and has also a recess *f* formed in it by means of a division piece f^1, between it and the barrel portion *a* of the casing, this division piece f^1 having a hole f^2 through it; this end of the casing has also a cover *g* attached, having an internal recess *i*; each of the covers are jointed to the ends of the casing, the outer edges of the diaphragms *h* and h^1 being placed between the flanges of the casing and the covers, thereby making a joint, so forming a chamber in each cover. The upper cover and diaphragm is of larger diameter than the lower one. Between the ends of the casing an annular projection is arranged, forming a valve seat. A connection *k* is also made in the upper part of the casing, above this valve seat, to the chamber in the lower cover. The two diaphragms are connected by a spindle *l*, this spindle passing through the hole f^2 in the division piece of the upper part of the casing. At a suitable place on the spindle is secured a valve *m*, which has for its seat, the annular projection *j* formed between the two ends of the casing. The upper portion of the spindle *l* is connected to the upper diaphragm *n* and has a small aperture l^1 through it, to allow air to be exhausted from the large chamber *i*, and also to admit air to this chamber. The lower or smaller diaphragm is of larger diameter than the valve *m* on the spindle, so as to act as a balance. A connection *n* may be made between the upper chamber *i* above the large diaphragm and an aperture in the driver's valve so that when the driver's valve is moved over, or opened, for the application of the brake with extreme rapidity and power, atmospheric air is admitted direct to the aforesaid upper chamber to destroy the vacuum therein, and forces down the diaphragm and its spindle moving the valve off its seat and allowing the full volume of atmospheric air to pass with full rapidity through the automatic valve for upsetting the equilibrium of the usual accelerating or quick acting valves so as to admit atmospheric air to the brake cylinders. Other forms of automatic valves are described in the specification. (*Accepted 26th January, 1905.*)

SPECIFICATIONS PUBLISHED.

A.D. 1904.

470. Wagon brakes; Greaves and Rippeth. 818. Electric railway systems; British Thomson-Houston Co., Ltd., Sporborg, Carter and Cubitt. 1796. Signalling apparatus; Higley. 1803. Carriage door lock; Castle, Grant and Castle. 1860. Conductors of electric railways or tramways; Boardman. 2286. Ventilating railway vehicles; Taylor. 2288. Electric signalling apparatus for tramways and railways; Wilson and Marshall. 2435. Structural intersections and crossings of tramways and railways; Kitchen. 3277. Coupling (automatic); Darling and Lennie. 3854. Ventilating railway carriages; Rowland. 3958. Automatic vacuum brakes; Churchward, Snell, Rayer and Dumas. 5019. Railway block signalling systems; Morton and Carson. 5306. Apparatus for communicating with guards and applying brakes on trains; Preston and Rock. 5322. Fastening carriage doors; Knowles. 5331. Opening and closing carriage windows; Altrichter. 5377. Dust screens for carriage windows; McLaren. 6367. Ventilating vehicles, &c.; Rushton and Store. 6564. Brakes (wagon); Liley and Jones. 6737. Couplings (automatic); Orosz and Garai. 6983. Apparatus for signalling, applicable to controlling engines and trains; Freeman. 7297. Axle boxes; Laycock. 7306. Operating wagon couplings; Woodward. 7750. Buffers; Heald, Wentworth and Rees. 9412. Automatic fog signalling apparatus; Johnson. 14880. Fastenings for carriage doors; MacKay. 14933. Safety devices for electric railways; Curwen. 15478. Spittoon for railway carriages; Harvey. 16266. Locking carriage doors; Parriss and Faries. 19875. Automatic block signalling system; Richardson. 20161. Sole plates and anchors for tramway rails; Walker and Grant. 23375. Propulsion of locomotives and vehicles; Granlund. 23724. Signalling and safety systems and apparatus; Schreiber. 24216. Simultaneously locking carriage doors in trains; Challenor and Pilling. 25576. Nut lock; Wegener. 25628. Rail joints and tie bars; Vosler. 25871. Switches; Fitzgerald. 26466. Rail joint; Watkins. 26489. Axle boxes for wagons; O'Donnell (Ferguson). 26885. Rail fasteners; Tibbets. 27200. Signal or other lamps; Welch. 28480. Securing freight upon trucks; Lewis. 28836. Means for automatically operating the whistles of locomotives; Fisher. 29040. Pressure regulating devices for air brakes; Turner and Custer.

Four-cylinder Compound Lignite-burning Express Locomotives in Bohemia; Austrian State Railways.

By Charles R. King.

In the last issue of the *Railway Engineer* some of the drawings of these interesting engines were published, and they will, together with those which accompany this description, render the construction of the engines quite clear.

These engines are used for working the express services between Gmünd and Prague, the capital of Bohemia. The fuel used is a Bohemian lignite of the poorest quality, but with this fuel they are, as is subsequently shown, effecting notable economies. This ability to use poor fuel with advantage appears to be due to the adoption of an especially large fire-box with an exceptionally large grate upon the same principles as those followed some years ago by Wooten in America and by Belpaire in Belgium, and both of whose fire-boxes were designed for burning inferior grades of coal slack.

The engine illustrated is the first of the great four-cylinder compound locomotives which have been built on the Continent since 1902, and it marks the most notable and recent progress in locomotive design made there. The newest engines in Austria, Baden, Bavaria and Hungary are all very fine types of express engines with four cylinders compounded according to the most approved system for such locomotives; that is, with the whole group of cylinders bolted together in the same plane below the

front end of the boiler and with all their connecting rods working on to the same axle—and not divided into two groups. This arrangement, which is the indicated system of the future, has been proved in practice to be the simplest and best for construction, for maintenance, and for attendance when on duty. Continental engineers now admit the necessity of at least four cylinders for the power now required in express engines for drawing heavy trains, and there are but few, outside France, who do not intend to employ the arrangement just noted. In Germany and in Italy it is the most approved practice.

In passing it may be timely to state, since some confusion exists on the point, that the two commonest arrangements of the two groups of cylinders of different expansions are due one to Mr. Webb and the other to Mons. E. Sauvage. The first, as it is known, consists of connecting the high-pressure and low-pressure cylinders to different axles, so dividing the engines into two groups—whether coupled or not coupled the principle is the same—while the latter arrangement, which promises to be the final one, simply consists of driving only one axle from all the cylinders. The engine of M. Sauvage (formerly of the Northern R. of France) was exhibited in Paris in 1889. Mr. Webb's engines were sent to France and to the United States, but it was only in France that his arrangement, slightly developed, attained any great success, and that just when he had, like others, adopted the Sauvage arrangement (also developed) for his later compounds.

The Bohemian locomotive illustrated is interesting in its general design (equally also as the other great Continental engines mentioned) for the enormous increase in the size of the boiler, and that, too, without exceeding the limit of axle loads which had already been attained by the much smaller locomotives of 1901. The very small loads of 14 to 16 tons per axle permitted for Continental locomotives are a source of constant perplexity to Continental engineers, and without which restriction their locomotives would have been, before now, much augmented in size. With such limitations of weight the only way to increase the power of the engines was to cut out all useless dead weight from them and their under carriages. By close calculations and subsequent trials the proportions of the parts indicated have been fined down to an extent so far unknown in English or American locomotives. A glance at the wheels, tyres, and especially the moving parts of the latter engines, as compared with the Continental examples, suffices to prove this. None the less it is quite possible that when English engines ultimately increase in size equal to those of the Continent it may be desirable, in order to keep down the weight, to follow to some extent Continental and not American practice in the proportions for the motion work.

The service for which the engines under notice were built is a fast one, comprising trains of up to 300 tons, while the gradients, up to 1 in 100, are long and frequent. The division upon which they are at work between Gmünd and Praja is about 200 *kiloms.** in length, and includes about 70 *kiloms.* of grades at 1 and 1·1 per cent. There are eight engines at present on the division named and nine on the Pilsen division. The same type has now also been adopted as standard for the Southern Railways of Austria (*Südbahn*) on the Vienna-Gloggnitz division, which has a continuous gradient of 25 *kiloms.* long, between Vienna-Neustadt and Gloggnitz, of 0·67 to 0·77 per cent. In Austria the maximum speed allowed is 90 *kiloms.* (55·9 *m.*) per hour, and the rules regulating the speeds under various conditions of service are very strict; and as a consequence these locomotives never have an opportunity of exerting their full speed capacity, as is permissible with locomotives in England and America. The rails are of a light section, generally 34 *klgms.* per *metre*, 9 *metres* long in old and 12 *metres* long in new rails. The sleepers are spaced from 80 to 90 *centimetres* apart. The load permitted per axle with such roads in Austria is (as in Italy) only 14½ tons.

In a special trial of one of the new engines (when for official purposes an exceptional speed was permitted) it attained with a light load, on a rising gradient, a speed of 88·6 miles per hour within a few minutes of starting, and with the greatest ease. The tachograph record of this run shows a remarkably steep curve of acceleration. In regular service a power of 1,600 h.p. has been indicated while hauling a net load of 230 tons on an incline rising 1 in 100, and at a continuous speed of 47 miles per hour. The principal features of these engines, known as Series 108, will now be mentioned. They were designed by the chief consulting engineer of the Austrian State Railways, Mr. Karl Gölsdorf, and were constructed at the fine new shops of the *Prvnicesko-Moravska Tovarna Nastroje v Prase (in Praja)*, or "First Bohemian Machine Works of Prague."

The principal dimensions are:—

- Cylinders, 13¾ ins. and 23⅝ ins. × 26¾ ins.
- Coupled wheels, 7 ft. diam.
- Heating surface, 2,269·3 sq. ft. in the tubes; 178·7 sq. ft. in fire box; 2,248 sq. ft. total.
- Grate area, 38 sq. ft.
- Boiler pressure, 220½ lbs. per sq. inch.
- Weight on coupled wheels, 29 metric tons.
- Weight of engine, empty, 60·5 metric tons; maximum in working order, 68·3 metric tons.
- Tractive effort, by formulæ $T = 0{\cdot}5\, p\, d^2\, l \div D$, = 17,190 lbs.
- In connection with this last item it may be interesting to note that the formulæ
  $T = (0{\cdot}67\, p\, d^2\, l \div D) + (0{\cdot}25\, p\, d^2\, l \div D)$,
  which is used in America and elsewhere for four cylindered compound engines, would give a higher value for these engines than that given above.

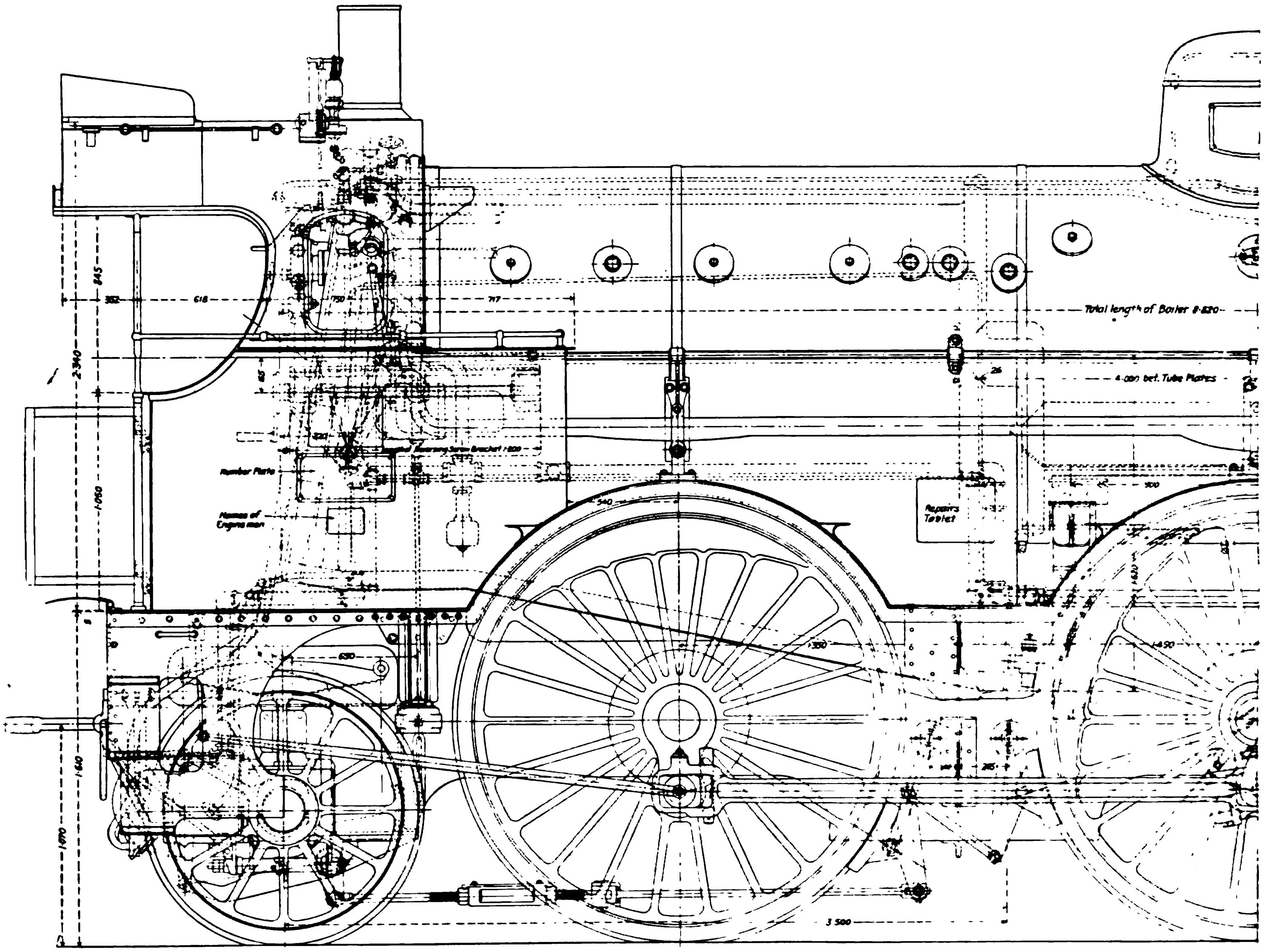
The two high-pressure cylinders are located inside and the two low-pressure cylinders outside the frames. The group is cast in two pieces with one high-pressure and one low-pressure cylinder in each half and bolted together at the middle, in the American way.

There are four slide valves of ordinary pattern with Trick steam channels. The designer, like some other eminent Continental engineers, maintains an objection to piston valves. The outside cylinder valves are driven direct by a Heusinger (Walschaerts') valve-gear and the smaller inside valves, indirectly, through rocking arms and a shaft, so that there is only one set of valve gears instead of the two sets as usual in the present French arrangement. The ratio of cylinder volumes, H.P. to L.P., being as much as 1-3, the designer considered that the present custom of giving the low-pressure valves a later cut-off was as superfluous as four valve gears.

The disposition here mentioned, but with a piston-valve for each cylinder, is now becoming the standard arrangement on the Continent.

The cranked axle is of the modern pattern, having an oblique arm of rectangular section connecting the single crank cheeks

* 1 *kilom.* = 0·621 *mile.*



Four-Cylinder Compound Lignite-Burning Express

near each crank pin. The engine axles are of 3% nickel Martin's steel, having an ultimate tensile strength of 55 to 65 *klgms.* per square millimeter, 20 to 15% elongation, and 40% cross-sectional contraction. The tests of the specimen lengths of the material, both for bending and for impact, were particularly rigorous, and especially so for the 3% nickel steel. These crank axles cost, all finished, 2 kronen 80 heller per kilogramme.*

The axles and wheels employed at the Praja works, as with all Austrian locomotive shops, are obtained from native steel works, and frequently from those of the Oesterreichen Alpine Montan Gesellschaft, of Neuberg-Zeltweg, and also from the great steel works of Witkowitz.

The wheel centres are steel castings. They are very finely proportioned, the weight of each one being only 1,558 lbs. The whole of the wheel-work of the driving and the coupled wheels weighs 16,245 lbs., or little over 7 tons.

The crank pins for the coupled wheels are hollow. The practice of boring out crank pins and connecting rod pins is extending on the Continent.

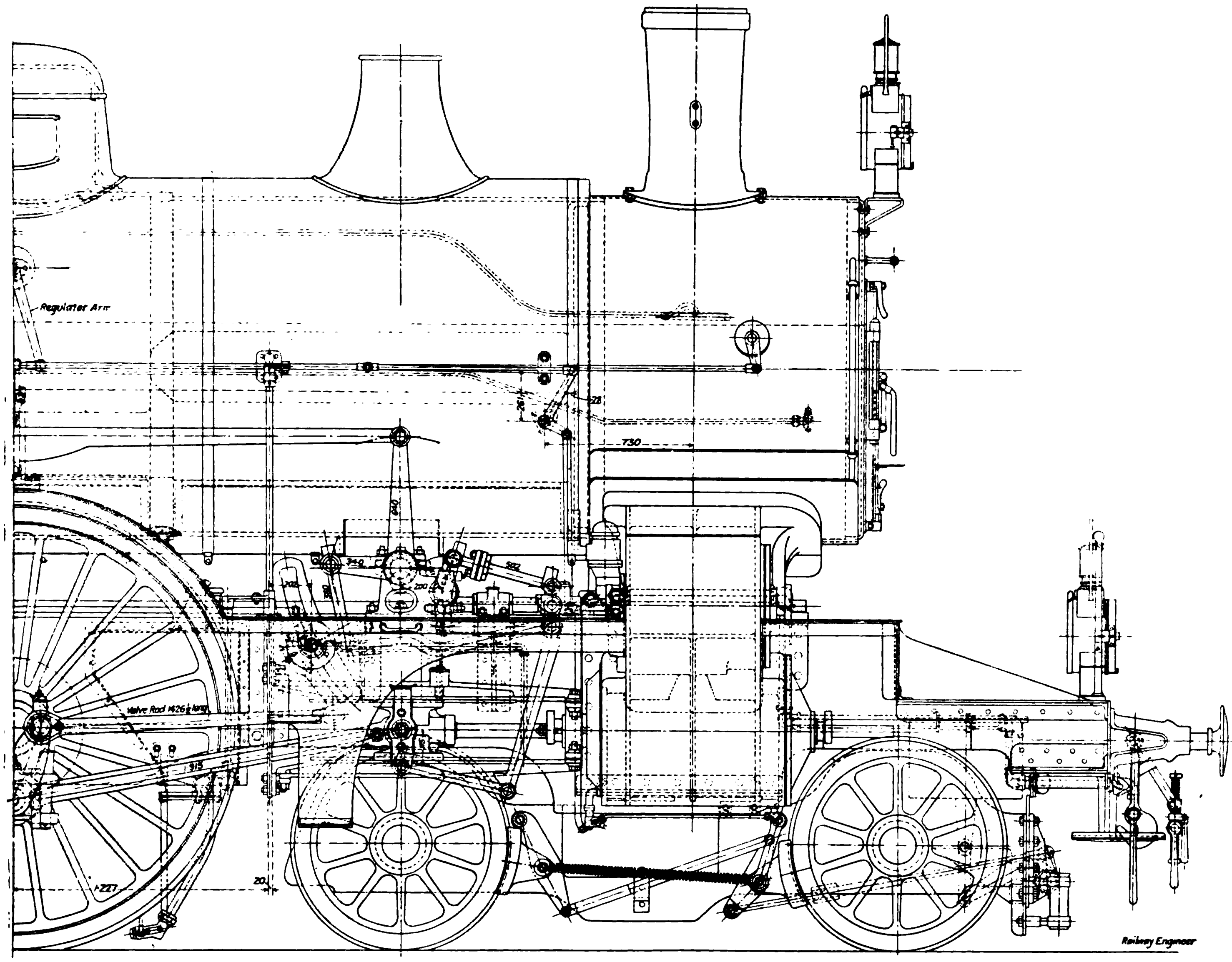
Equalising-levers connect the driving-springs longitudinally with the transverse equaliser employed for the rear carrying-wheels. By means of this arrangement it will be possible to increase the load on the drivers up to 16 tons per axle when in a few years time the strengthened Austrian tracks will permit of the increased weight.

The carrying wheel axle boxes are radial with as much as 7 *centimetres* play on either side but without the controlling springs that are so often employed. The horn blocks of this axle are, along with the frames, rigidly stayed together at this point by four bars 1 inch diam., two on each side of the axle.

At the opposite end of the engine there is no play allowed, for the bogie is merely a swivelling truck without any transverse displacement for its pivot. In this manner the front end of the engine is more rigid than the back end and the arrangement should tend somewhat to reduce the sharp lateral shocks commonly felt upon the foot plate of "Atlantic" type locomotives.

The bogie pin fits in a spherical collar and not in a step-bearing, its work, therefore, being simply to push the truck without carrying the weight of the engine frame, which is, instead, supported entirely by two half spherical side rests under the cylinder casting and resting in grooved seatings upon the outer edges of the bogie frame. The front end of the engine is consequently less yielding vertically and transversally than it has been usual to make Continental locomotives in recent years.

*About 1s. per lb. or £112 per ton.



Locomotives in Bohemia; Austrian State Railways.

Brake blocks are fitted to the front truck wheels and operated by a vacuum cylinder.

With the object of reducing weight the crosshead guide bars are made of steel castings of I section. The cost of these bars by reason of the difficulty of getting castings answering all the conditions required of them appear to come out more expensive than ordinary forged ones despite the fact that they have only one machined surface as against the four surfaces of the forged bar.

Steel castings are also employed for the crossheads, pistons, and horn blocks. According to a very good plan followed in Austria and Italy for four-coupled engines the stress of the main connecting rods is taken by the crank-pin close up to its seat in the crank boss, while the coupling rod, which is usually placed to the inside, here fits outside of the main rod. The consequent advantages are lessened fatigue for the pin, lessened leverage on the driving wheel bosses, and steadier movement of the engine-while coupling-rods are more easily removed for brass renewals.

In accordance with the usual Continental practice the piston and valve rods have tail-end extensions, which tend to prolong the wear of the piston rings, cylinders, and valve faces.

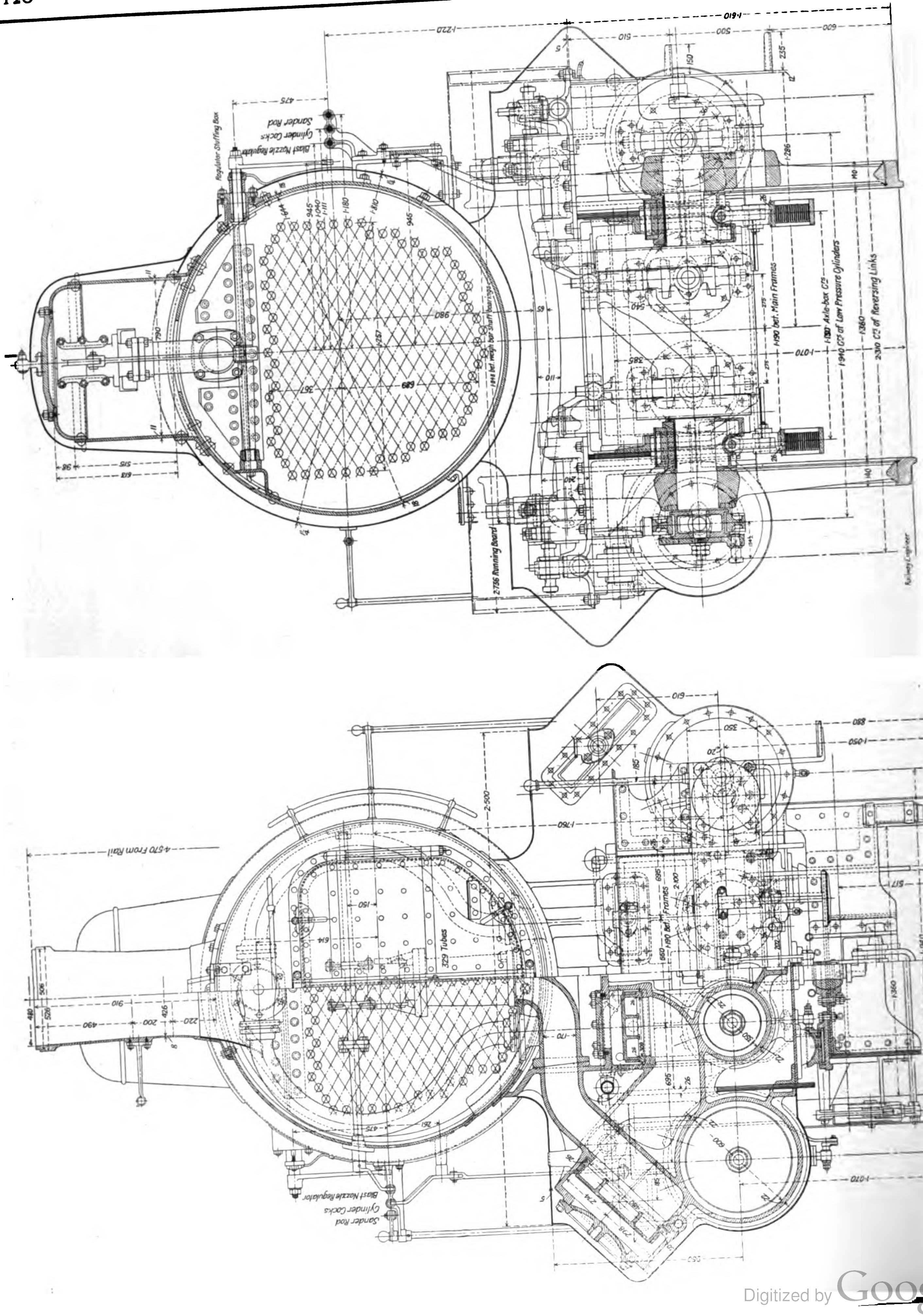
The principal feature to note in the boiler construction is the use of gusset stays for the fire-box back plate in place of the more usual palm-stays, or, rather, the system of girder plates and diagonal rods. At present many locomotive boilers are being constructed in this way in Austria. Gusset plates are also used, as customary, for staying the circular front tube plate.

The fire-box crown is stayed to the curved fire-box shell with direct stay-bolts, except in the two forward rows, which are slung stays supporting short one-ended crown girders.

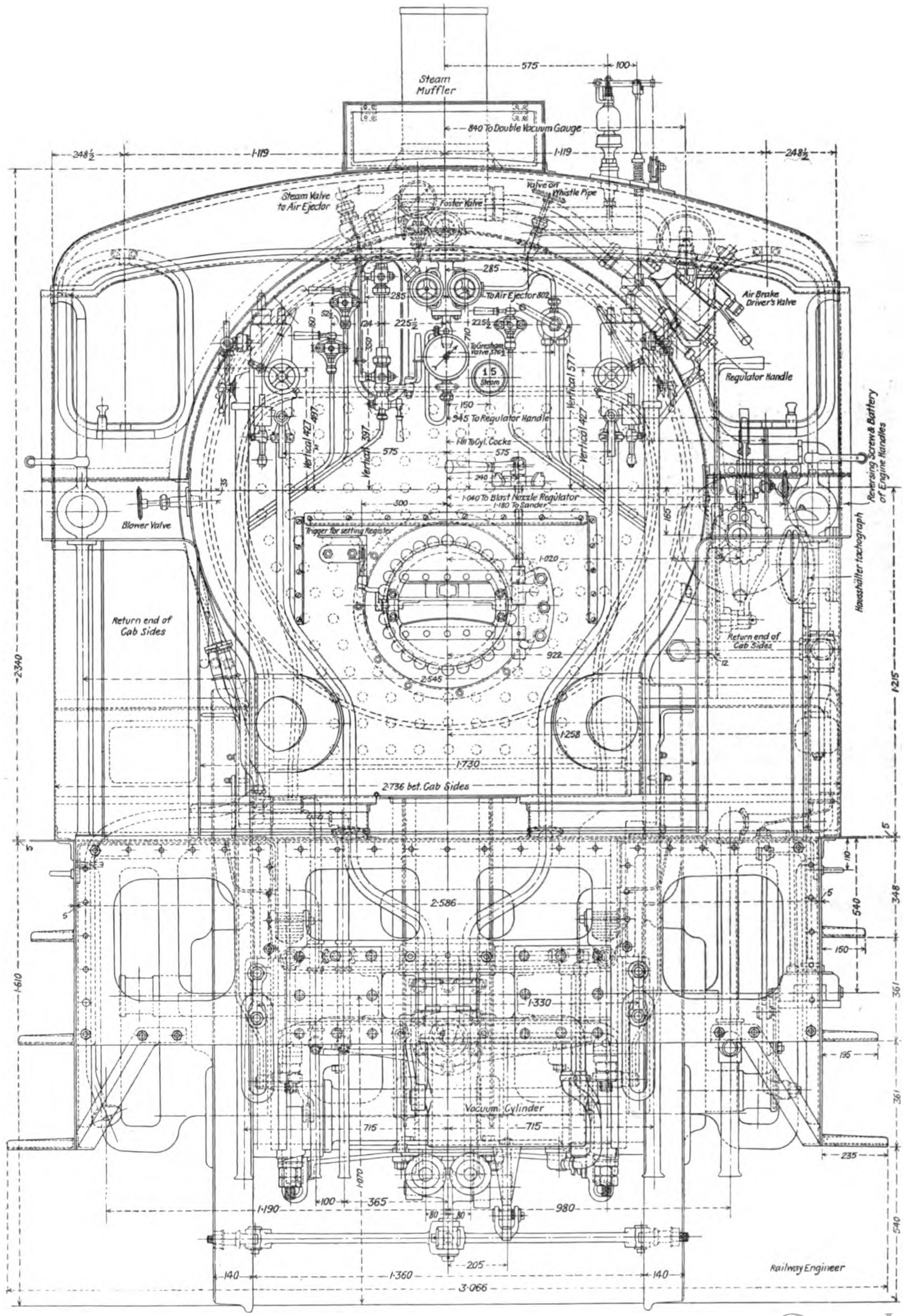
The back of the fire-box is sloped in the American way, the advantage of this practice being to allow, with a given weight of material, a fire-box of larger effective heating surface and a longer grate, because the area above the fire-hole, whenever the back plate is vertical, is not subjected to the direct heat from the fire, owing to the powerful action of the blast. The inclination of the back plate has, however, constructional limits.

The fire-hole is round and of very small size relatively for such a capacious box, although apparently all-sufficient in practice.

The plates of the steel and copper boxes are flanged and riveted together according to the Webb plan now much employed in Central Europe. The fire door is fitted in its upper half with the "Mareck" pivoting deflector, which acts with great efficiency, owing to the air, introduced by it, sweeping the top of the fire and increasing the combustion. A feature of the device is that it



Four-Cylinder Compound Lignite-Burning Express Locomotives in Bohemia; Austrian State Railways.



Four-Cylinder Compound Lignite-Burning Express Locomotives in Bohemia; Austrian State Railways.

closes each time that the door is opened, but, by means of a latch or trigger fixed to the fire hole ring, is always re-opened automatically by closing the door, unless the trigger is first put out of gear, when it remains shut.

(To be continued.)

Official Reports on Recent Accidents.

At **Forden C.Rs.** *on the 26th November. Lt.-Col. E. Druitt, R.E., reports that*:—

The 7.5 p.m. down passenger train (4-coupled bogie engine, tender, 4 carriages, and a covered van fitted throughout with the vacuum automatic brake) from Welshpool to Llanidloes ran into the engine and 6 waggons of an up goods train which were standing on the down line of the crossing loop at Forden Station. Five passengers, the fireman of the goods engine, and the station master were injured.

Forden is a passing place and tablet station on a single line.

R. Ashton, the signal porter at Forden, accepted the goods train from Montgomery (2 miles) at 6.55 p.m. and the passenger train from Welshpool (4½ miles) at 7.3 p.m., the respective tablets being taken out at those times at the places mentioned. He received "Train entering section" signal for the goods train at 7.9 p.m. and for the passenger train at 7.12 p.m. Both the home and both the distant signals were at danger. The goods train arrived and came to a stand at the home signal at 7.13 p.m. Mr. Corfield, the stationmaster, was in the signal-box with Ashton at 7.9 p.m., when the "Entering section" signal for the goods train was received, and knew that a tablet for the down passenger train due at Forden at 7.15 p.m. had been issued at 7.3 p.m.

But he met the goods train at the up home signal, and after the engine and the first six trucks had been unhooked ordered the driver to draw ahead on the down road for the purpose of unloading four horses in the sixth truck. The driver states he drew Mr. Corfield's attention to the fog, as, knowing the passenger train was due, he thought there would be some risk in the proceeding, but he was told to go ahead. The engine and six trucks accordingly were drawn forward on the wrong road, and came to a stand at the north end of the platform at about 7.15 p.m., and three minutes later, while the work of unloading the horses was proceeding, the passenger train arrived, and over-running the home signal, which was at danger, collided with the engine of the goods train, which was standing 120 yards inside that signal.

The collision was thus due to Mr. Corfield's action in breaking the rules for working single lines of railway on the electric train tablet system, and in driver Hughes' neglect to sufficiently reduce speed when he failed to observe the distant signal so as to be able to stop at the home signal. No doubt, having received no warning at Welshpool that the road was blocked at Forden Station, he assumed that it was clear for him to run into the station as usual, and this he did at the usual speed, and so when he found the home signal at danger on passing it he was unable to pull up in time to prevent a collision. The evidence is conflicting as to the amount of fog at the time, but no doubt it was fairly thick, and so there was all the more necessity for careful driving.

Both Hughes and his fireman were unable to say at what speed they were running when they found they could not see the distant signal and also when passing the home signal, although they both knew they were approaching Forden Station. Mr. Corfield's action is difficult to understand. He states his reasons for bringing the horse truck to the down platform to unload were, that this platform being higher than the up platform (3 ft. against 2 ft. 6 ins.) it is easier and safer to unload horses out of trucks at it, and that he was anxious not to delay the goods train, which was already late, and as he thought there was enough time to unload the horses before the arrival of the passenger train.

Also he states that he had on several occasions told Ashton to turn the down facing points so as to lie for the up loop line when shunting was going on on the down loop line and a down train approaching. Ashton denies this.

*

Near **London Bridge Station, L.B. & S.C.R.,** *on the 18th November. Lt.-Col. P. G. von Donop, R.E., reports that*:—

The 6.30 p.m. passenger train (2 engines and 14 vehicles) came into collision with a light S.E. and C. engine, which just touched the second engine and then fouled the five next vehicles of the 6.30 train. The light engine and the carriages were considerably damaged. About 20 passengers complained of slight personal injuries.

The low level S.E.R. London Bridge Station immediately adjoins the Brighton Co.'s station. It has 4 platform lines, No. 1 being on the south-west side of the station and No. 4 on the north-east side. Each of these platform lines has connections leading to and from the up and down main lines, which run out of the station in a south-easterly direction, the down line being on the north side.

The Croydon trains of the L.B. and S.C.R. Co. run for a short distance over these same main lines from a point just outside the London Bridge Stations, and these main lines are therefore known as the Joint Main lines. In order to give access to the Joint Main lines the platform lines of the Brighton Co.'s station have connections leading to a pair of up and down lines which have a double junction with the Joint Main lines about 160 yards to the south-east of the Brighton Co.'s station.

The passenger train concerned in this collision was running out of the Brighton Co.'s station on their down line through the double junction on to the down joint line; in so doing it had to cross the up line into the South-Eastern Co.'s low level station.

The light engine concerned in the collision was being backed in the down direction from the low level station along the S.E. up line, and the collision occurred at the fouling point between the Brighton down line and the up line.

This fouling point is situated 60 yards to the south-east of the S.E. "B" signal-box.

The running of the Brighton train was controlled by three signal-boxes, viz.:—

(1) The Brighton Co.'s north signal-box, situated on the south-west side of that Co.'s lines and about 20 yards to the south-east of their station.

(2) The Brighton Co.'s south box, also situated on the south-west side of their lines and 120 yards to the south-east of the north box.

(3) The S.E. Co.'s "B" signal-box, fixed across their lines at a point about 300 yards to the south-east of the buffer stops at the north-west ends of their station platform lines.

The signal for running from the Brighton down line through the double junction on to the down joint line is fixed on a gantry across the Brighton lines situated 30 yards to the south-east of their north signal-box. This signal is worked from the Brighton north box, but both the south box and the S.E. "B" box have slots controlling it, so that it cannot be lowered without their concurrence. Owing also to the "lock and block" arrangements which are in use on the Brighton line this signal cannot be lowered until the signalman in the north box has received "Line clear" from the south box, and that cannot be given until the signalman in the south box has similarly received "Line clear" from the "B" box.

The signal therefore for a train to run from the Brighton Co.'s station to the down joint line cannot be lowered until the signalmen in both the south box and the "B" box have each of them given "Line clear" for the train and have also each pulled over their levers working the slots on that signal.

The movements of the S.E. light engine were controlled entirely from the "B" signal-box.

There is on the up line running into the low level station a facing point situated 70 yards to the north-west of the "B" signal-box. The left-hand connection leads to No. 1

platform line, and the right-hand one to No. 4 platform line. The light engine was standing on No. 1 platform line and it had to run from that line on to No. 4 platform line; it was necessary therefore for it to be backed in the down direction along the up line until it was clear of the facing point, and then to be run along the connection leading to No. 4 line. There is no signal provided for backing along the up line, but a disc signal is provided for shunting through the facing point in the up direction. This shunting signal is situated 4 yards to the south-east of the "B" signal-box, *i.e.*, 74 yards from the facing point.

All the necessary preliminaries were duly carried out before the signal was lowered for the Brighton passenger train to run through the double junction on to the S.E. down joint line. Signalman Day, who was assisting Cheeseman in the "B" box, and who was chiefly concerned with the movements of the light engine, states that he knew that Cheeseman had accepted it and that it was about to run on to the down joint line.

The S.E. and C. engine had brought a train into No. 1 platform line, and had to be crossed to take a train from No. 4 platform. With this object in view Signalman Day at 6.34 p.m. telephoned from the "B" box to Inspector Mann, who was on duty on the platform, asking him to let the light engine back out on the up road so that it might be run into No. 4 platform line. Inspector Mann clearly understood what it was proposed to do with this engine.

Meanwhile shunter Flood joined the light engine, and he knew how it was customary to deal with the engine. He gave driver Skinner instructions to run up to the platform starting signal, and whilst the engine was on the move Inspector Mann came out of his hut and gave further instructions to the shunter, and also to the driver, who was leaning over the engine towards him, "Right out on the up road, but do not go beyond the cabin." Skinner appears to have only heard Mann say "Right out on the up road," but Skinner admits that, though he did not know where he was subsequently going, he fully intended to stop his engine at the "B" signal-box, which, he says, is the recognised place at which to stop when backing out on the up road. The light engine accordingly ran on along the up line towards the signal-box at the same time that the passenger train was running out of the Brighton Co.'s station to cross that up line.

There was a fog at the time, and it is also admitted by all the witnesses that at the moment when the light engine approached the "B" signal-box the steam from the two engines of the Brighton train was hanging about and interfering considerably with the view. Consequently neither the shunter, nor the driver, nor the fireman of the light engine appear to have seen the signal-box until they were immediately under it.

Signalman Day states that he showed a green light from the window of his signal-box for the light engine to run out of the station, and he watched the engine doing so. When, however, the engine reached the tank, situated about 100 yards from his box, he lost sight of it owing to the steam, so he at once altered his lamp to show a red light. He did not, however, see the engine again until it was right under his box, when both he and his assistant, Cheeseman, shouted to the driver to stop. Driver Skinner states that he was unable, owing to the fog and steam, to see the signal-box, and that the first he knew of his being near it was hearing the shouts of the signalmen. He immediately applied his brakes, but owing to his wheels skidding he could not bring his engine to a stand before just coming into collision with the passenger train at the fouling point of the two lines on which they were respectively running. Shunter Flood does not appear to have taken any steps to make the driver stop until they were within three or four yards of the box. He admits that he was in charge of the shunting operation, but he states that he trusted to the driver stopping in time.

There can be no doubt that both shunter Flood and driver Skinner omitted to exercise proper care when carrying out this shunting operation with the light engine. They were both fully aware that it was not safe for the engine to run past the "B" signal-box, and yet the engine was allowed to run up to the box at such a speed that it could not then be stopped in the length of 60 yards which intervened between the box and the fouling point between the two lines. It is allowed that, owing to the steam, they were unable to see the box till they were almost under it; but, under those circumstances, it was clearly their duty to have brought the engine to a standstill until they could ascertain for certain where they were. Instead of doing so, the engine was allowed to run on at a speed which the shunter himself allows to have been beyond the ordinary. The occasion was one which called for special care, which neither the shunter nor the driver appear to have exercised.

The backing of a light engine along the S.E. up road towards the point where it fouls the Brighton down line is undoubtedly an operation which is attended with a certain amount of risk. The S.E. and C. Co. recognise this fact, but, as it is impossible to carry on the London Bridge Station work without doing so, they guard against danger by making it a rule that, firstly, there shall always be a shunter in charge of the operation, and, secondly, that the engine shall never be taken beyond the "B" signal-box, which is 60 yards from the fouling point, and which by its position over the lines is a very clearly marked stopping place. These precautions should meet the case, but it is essential that these rules should be strictly adhered to, and that the shunter who is in charge should be a duly qualified man who thoroughly understands and appreciates his responsibility. The shunter who was in charge on this occasion had only been employed three months as a shunter, and, though he admits that he was in charge of the movement, he does not appear to have realised his responsibilities in the matter.

The only other point to which attention is called is the position of the disc for shunting through No. 61 points in the up direction. This disc is, as above stated, situated 74 yards from the points and 54 points from the fouling point at which this collision occurred. There seems no special reason for this disc being so far from the points, and in its present position it rather encourages drivers who are backing along the up road to run up to it, and consequently to run nearer the fouling point than there is any necessity for. The Co. might therefore consider the desirability of shifting the position of this disc to a point nearer the facing point to which it refers.

*

At **Anchor Pit Junction, Brighouse, L. & Y.R.,** *on 7th December. Lieut.-Col. E. Druitt, R.E., reports that:—*

The 10.50 p.m. goods train—Bradford to Wakefield—was run into by the 10.15 p.m., Salford to Hull, down goods train. The guard of the Bradford train was killed, and the driver and fireman of the Salford train were slightly injured.

The Bradford train arrived at Anchor Pit Junction, and was brought from the branch line on to the down north line, and came to a stand clear of the junction points, with the guard's van about 70 yards from the signal-box, in order to set back into the down loop and sidings. It arrived at 1.59 a.m., but could not be at once taken into the sidings, so waited on the down north line.

Shortly afterwards, at 2.1 a.m., W. Robertshaw, the signalman on duty at Anchor Pit Junction signal-box, received the circuit message regarding the running of the Salford to Hull express goods train, and this was offered to him from Brighouse East signal-box, on the down north line, at 2.12 a.m. Forgetting all about the train already standing on that line, he at once accepted the express and lowered his signals, with the result that the express ran into the van of the standing train at 2.16 a.m.

The apparent causes of the lapse of memory on the part of Robertshaw were that, at 2.10 a.m., he was called to one of the telephones in his box to take down a message regarding the relief of a driver of another train, and while engaged in this he was offered the express goods train at 2.12 a.m.,

which he accepted without thinking, and then went back and completed the transmission of the message at 2.14 a.m.

Robertshaw would have been reminded of the standing train had guard Dewis of that train carried out the Rule No. 55 (*a*), and gone to the signal-box and remained there until his train could be let into the sidings; unfortunately, he remained in his van, and lost his life.

The driver of the express had no chance of avoiding the collision. He was running with all signals off at close on 30 miles an hour, with a long and heavy train behind him, consisting of 89 waggons weighing 700 tons, and with no braking power beyond that available on his engine. Owing to the curve of the line it was impossible for him to ascertain that the tail lights of the brake van of the standing train were on an obstruction on the down north line until he was 250 yards from it, and in that distance he could not appreciably diminish speed.

*

At **Hitchin, G.N.R.,** *on 20th December. Lieut.-Col. R. E. Druitt, R.E., reports that:—*

The 5.20 p.m. up passenger train from Hitchin was standing at Hitchin South box slow line home signal when it was run into from the rear by two light engines coupled together. Seven passengers and the guard were injured.

The ordinary rules of block working are not in use at Hitchin Station, but the following rule was promulgated in 1897:—

Instructions to Signalmen.—Hitchin Yard Box:—The up slow starting signal must never be lowered for a passenger train to proceed to the south box until "Line clear" has been received for it from that place, nor must the signal be lowered for a train of any other description after a passenger train has left the platform for the south box until such passenger train has passed the south box and "Out of section" has been received by the yard box from the south box for it.

When the passenger train left the station at 5.21 p.m. the two engines followed it down and came to a stand at the up slow starting signal, and signalman Coulson (yard box) intended to keep them there until he received "Train out of section" signal for the up slow passenger train from the south box.

At 5.17 p.m. an up goods train arrived on the up slow line and was kept at the yard box up slow line home signal, and after the two light engines had followed the passenger train down to the up starting signal Coulson allowed the up goods train to draw into the station, and it came to a stand with the brake van 10 yards or so north-west of the up sidings points, through which it had to be shunted into the sidings. It was not a long train, but no doubt the driver stopped on seeing the light engines in front of it.

Coulson then, wishing to get the goods train to draw ahead so as to clear the points, lowered the up starting signal, forgetting the two light engines standing at it. The driver of the leading engine, thinking the signal was lowered for them to proceed to the south box, went ahead and ran into the rear of the passenger train which was still standing at the south box home signal.

Although the collision was due to Coulson's lapse of memory and to the dense fog which prevented him seeing the light engines at the starting signal, and the driver of the leading light engine seeing the tail lights of the passenger train, yet he was wrong in lowering his starting signal for any purpose whatever until he had received "Out of section" signal for the up slow passenger train. Had he wished to get the goods train a few yards beyond the starting signal he should have waited until he could send the fogman acting under his orders to verbally inform the driver, as it was impossible to see a hand signal owing to the fog.

The company are issuing instructions to the effect that in foggy weather passenger trains are to be kept at the platform until line clear can be given for them to proceed out on to the fast line at the south signal-box, which will prevent the recurrence of a similar accident.

In **Exchange Station, Manchester, L. & N.W.R** *Col. H. A. Yorke reports that:—*

The 8 a.m. train empty from Windermere was standing at No. 5 platform, Exchange Station, when it was run into in rear by the 9.30 a.m. train from Liverpool. Four passengers complained of shock.

The Liverpool train was travelling at a speed of about 4 or 5 miles an hour at the time of the collision: 2 coaches in each train were badly broken, and 7 slightly damaged. The engine of the Liverpool train had its front steel buffer beam and buffers broken and fore part of the frame badly bent. The brake blocks had not been released from the wheels of the stationary train.

The Company have received permission from the Board of Trade to dispense with block working through this station, and the traffic is therefore worked on the permissive system, more than one train being allowed to be in a section, or at a platform, at one and the same time. But in such cases, when a section or platform is already occupied by a train, the Company's rule (quoted below) is that any following train is to be brought to a stand at the home signal, before the "calling-on" arm is lowered to allow it to enter the station behind the previous train.

This collision must be attributed to a want of care on the part of driver Pywell, who allowed his train to enter the station at too high a speed, and was therefore unable to stop it short of the other train, which was already in the station, and overlapped the scissors crossing signals by 20 yards. He attributes the collision to the fact that his train was not stopped at the home signals before being allowed to proceed. His argument is that as the "calling-on" arm was lowered before he came to rest, he understood that the line was clear as far as the next signal or signals, *i.e.*, the scissors crossing signals, but that if the arm had not been lowered until his train was at a stand, he would have understood that the line was not clear up to the scissors crossing signal. This is an entirely new interpretation of the rule regarding the use of "calling-on" arms. The rule as to "calling-on" arms is perfectly clear. It says that "when a 'calling-on' arm is lowered, the engine driver must draw forward past the post of the signal on which the 'calling-on' arm is fixed *as far as the line is clear.*" That defines the driver's duty.

The rule further says that "unless instructions are issued to the contrary, the 'calling-on' arm must not be lowered until the train has been brought to a stand at the home signal." That defines the signalman's duty.

*

At **Enfield, G.N.R.,** *on 22nd December. Lieut.-Col. E. Druitt, R.E., reports that:—*

The 8.9 p.m. train from Moorgate Street ran into the buffer stops. One passenger and the front guard were slightly injured.

The leading bogie and the four coupled wheels of the engine left the rails and the buffer stops were carried away. The accident occurred at 9.31 p.m. during a dense fog.

The home signals are 355 yards from the buffer stops and the distant signals are 698 yards beyond the home signals.

Driver Toms and fireman Rumble were unable to distinguish any signal or to see any lights to enable them to discover their exact position on approaching Enfield Station. Both the home and distant signals being "off" for them, no detonators were laid, and when the fogman at the home signal shouted to them they state that they thought they were passing the distant signal. When driver Toms was uncertain as to his exact position approaching the station he did not wish to stop for fear of the passengers getting out in error, thinking the train was at the platform, so he proceeded cautiously with the brake blocks just rubbing on the wheels, and could have stopped the train in a few yards' distance at any time had he realised that he was in the station.

It is a point worthy of consideration whether fog signals should not be laid at the outer end of platforms of terminal stations during very dense fogs.

Editor's Notice.—All manuscripts and communications should be distinctly written, or preferably type-written, on one side of the paper only, and addressed to the Editor, **3, Ludgate Circus Buildings, London, E.C.** The Editor cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped directed envelope.

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THE
Railway Engineer

VOLUME XXVI., No. 304. *MAY*, 1905.

Contents for May.

The Earl of Dalkeith, deputy-chairman of the North British R., has been elected chairman of the company in succession to the late **Mr. G. B. Wieland**.

Mr. Clarendon G. Hyde, 4, Pump Court, Temple, E.C., has been elected a director of the Lancashire, Derbyshire and East Coast R. This company is sadly in need of "new blood."

Mr. D. C. Rattray, assistant engineer of the Lancashire and Yorkshire R., has been appointed engineer-in-chief in succession to Mr. W. B. Worthington, who has accepted the similar position on the Midland R., vacant by the death of Mr. J. A. Macdonald, and **Mr. A. Watson** has been appointed to succeed Mr. Rattray.

Mr. F. S. Barnes has been appointed outside assistant, carriage and wagon department, Lancashire and Yorkshire R., in succession to Mr. F. W. Attock.

Mr. E. Notter has been appointed district locomotive superintendent of the Great Northern R. at King's Cross in succession to Mr. F. Wintour.

Mr. W. Cleaver has been appointed engineer, and **Mr. A. H. Hertz** locomotive superintendent, of the Port Talbot Railway and Docks, in succession to Mr. W. J. Hosgood.

Mr. Dugald Drummond's title has been altered from "locomotive superintendent" to that of "chief mechanical engineer" of the L. and South Western R., and the electrical plant has been placed under his charge.

Mr. Samuel Bower has been appointed assistant accountant of the Midland R.

Mr. H. F. Golding, chief draughtsman of the locomotive department, Taff Vale R., has been appointed assistant locomotive superintendent at Penarth Dock.

Mr. W. Clow has been appointed assistant superintendent of the line in succession to **Mr. S. H. Fourdrinier**, who has retired.

Mr. Philip Burt, general traffic manager, has been appointed deputy general manager of the North Eastern R.

We regret to record that **Mr. Geo. B. Wieland**, chairman of the North British R., died at Mentone on the 26th March, on his way back from Egypt, where he had been for the benefit of his health, and was returning to hold the half-yearly meeting of his company. He was a Londoner and began his career in a L. and North Western R. booking office. He was promoted to the general manager's office, and in 1873 obtained the appointment of secretary to the North British R., which position he held until 1892, when he resigned and was elected to a seat at the board. When Lord Tweeddale resigned, as a consequence of Mr. Grierson's circular in 1899, Mr. Wieland was offered the chairmanship but declined it, but on the resignation of Sir Wm. Laird in May, 1901, he accepted the position and held it up to the time of his death. He was in his 68th year.

*

International Railway Congress.

THE International Railway Congress meets at Washington this month. It opens on the 4th and closes on the 13th inst., after which the delegates will take either a short or a long tour ending at New York on the 23rd or 27th inst. respectively, and covering either about 1,500 or 2,700 miles, and visiting the principal centres of railway interest. The hospitalities arranged by the American railroad companies are upon a gigantic and lavish scale. The papers to be discussed are with some few (chiefly American) exceptions, like their predecessors, mainly remarkable for the skill with which the facts and data are swamped with verbosity. But few of the delegates read the papers, and still fewer discuss them. A large number of English and Irish railway officials have been "delegated" by their respective companies to attend this congress, and it is gratifying to see the names of so many younger officials in the list, especially from the larger railways.

*

Demurrage on Private Owners' Wagons.

THE Railway and Canal Commission decided, in the case of Charrington, Sells, Dale and Co. *v.* L. and North Western R. that three days was a "reasonable" time for a journey, and that 6*d.* per day per 10-ton wagon was a "reasonable" amount for demurrage if the "private" wagon were detained longer than the "reasonable" time on the journey.

The result of this decision will tend to prevent the collection of traffic into big units, and also will make railway companies more particular about siding rents in order to keep their yards as clear as possible.

How much easier and smoother railway working would be if there were no "private" owners' wagons at all.

German Gas, Water and Steam Tubes.

WE are informed that Messrs. Chas. Hatton and Co. and Mr. Ed. Lomer have been appointed sole agents for this country for the syndicate which controls the entire output of gas, water, and steam tubes up to 4ins. diam., of twenty German firms, and which rejoices in the title, *Verkaufsstelle der Deutschen Gas und Siederohrwerke Gesellschaft mit beschränkter Haftung* (German Gas Tube Export Syndicate). We hope that our railway companies will see that their interests lie in supporting home industry and not "dumping," and will remember that there are several firms in Staffordshire and other places at home that can do very well with all their orders just now.

*

Victoria Bridge over the Zambesi River.

THE British South African Co. were able to announce that on the 1st ult. the two halves of the great bridge, the highest in the world, over the gorge at the Victoria Falls, on the Zambesi River, "met exactly" at 7 a.m. in the presence of Sir Charles Metcalfe, their consulting engineer in Rhodesia. This bridge was designed by Sir Douglas Fox and partners, and was made in England.

*

Egyptian State Railways.

LORD FARRAR's Commission have condemned as unsatisfactory the system under which the Egyptian State Rs. have been administered, and which consisted of a "Board of three persons "whose functions are not specially defined," but which "appear "to be limited to the control of the operating staff, and to seeing "that the railways are worked at an agreed percentage, which has "varied at different times from 33 to 54 per cent. They also "have to control the Port of Alexandria and the telegraphs."

The report is a voluminous one and we hope to deal with it more fully at a future date, but for the present it must suffice to say that the Commission recommend the abolition of the present Board and the appointment of "one chief having powers "analagous to those of a managing director, or general manager in "other countries," responsible for the State Railways and Telegraphs to a State Council consisting of at least five members, who might take cognisance of all other transport agencies in the country. Such a council not to interfere directly with the executive, but to sanction expenditure, "in fact to be the watch dog of the Government *vis-a-vis* the railways."

This recommendation has already been acted upon, and Major J. H. L'E. Johnstone, R.E., president of the Board, has been appointed general manager.

Subject to the chief officer there should be more than four or five heads of department, viz., traffic, accounts, way and works, mechanical and electrical engineering, and stores and purchase.

The Commission recommend the capitalisation of the State railways, and suggest L.E.21,275,000 as a fair value, this sum being 20 times the net revenue for 1903.

The Commission condemns the posposal to widen the gauge of the Luxor-Assouan line from 3ft. 6in. to 4ft. 8½in., the gauge of the State railways, and considers it would be more remunerative to spend L.E.1,000,000 in linking up the line with the 700 miles of railway in the Sudan, than to spend L.E.600,000 in widening its gauge to that of the State railways.

Record Postcard Sales.

WHAT we believe to be a record in the sale of pictorial postcards has been achieved by the L. and North-Western R., whose excellent views of engines, carriages, bridges, and the "beauty spots" served by their system are now so well known. First published in August last the cards sold up to the end of March numbered 2,212,900, a monthly average of 276,612. This is doubtless attributable to the very low price—twopence for six cards—combined with the highest quality.

The cards are still on sale at stations, town offices, &c., and will come in useful for the holidays.

Books, Papers, and Pamphlets.

River, Road, and Rail, BY FRANCIS FOX. London: John Murray, Albemarle Street, W. 1904.

Curious experiences fall to the lot of most engineers, especially those engaged on large works in "new" countries. It is not therefore surprising that the reminiscences of Mr. Francis Fox, who for the greater part of his life has been a partner in one of the most extensive consulting practices in the world, should be both numerous and varied. As such anecdotes and experiences too often go unrecorded, it is a matter for congratulation that Mr. Francis Fox has been persuaded to write his delightful book.

The incidents are drawn from all parts of the world, and most of them have some professional point which renders their narration valuable to the young or less experienced engineer as well as interesting to the older engineer and non-technical reader. Considerable space is devoted to two works which just now are attracting much attention, viz., the Simplon Tunnel and the bridge over the Zambesi near the Victoria Falls. Mr. C. Beresford Fox, the author's son, was the first man to cross the gorge on the wire rope, and an interesting illustration of him suspended in mid-air while doing so is an attractive feature of the book. The two coloured comparative plans of the Victoria and the Niagara Falls are both useful and interesting. And, indeed, it may be said that all the illustrations are good and of especial interest. The author's father, Sir Charles Fox, erected, in conjunction with Sir Joseph Paxton, the great building of the 1851 Exhibition—now the Crystal Palace—and the contents of the book cover the period of time from the construction of that building down to the single-span bridge over the Zambesi River in Africa; and when one calls to mind the number of public works the author's firm have been connected with during that period a fair idea is obtained of the extent of the field the author had at his command.

*

Transactions of the Junior Engineering Society, Swindon, 1903-4. Edited by G. IRELAND. Published by the Society, G.W.R. Loco. Dep't., Swindon, 1905. [Price 5s.]

The papers recorded in this volume are: *Carriage and Wagon Rolling Stock*, by F. W. Marillier; *Iron and Steel and their Analysis*, by R. L. Burge; *Modern Automobile Construction*, by P. Warren Noble; *Sewerage and Sewage Disposal*, by Cecil T. Cuss; *Internal Combustion Engines*, by B. Humphrey; *Improvements in Gas Works Appliances*, by David G. Slatter; *The Metallurgy of Copper*, by Trevor Roberts; *Steam Freight-carrying Vehicles*, by V. Bayley: *Great Western Railway Locomotives, "La France" and "Albion,"* by G. H. Burrows; and *Valves and Valve Diagrams*, by W. H. Pearce. These papers and the discussions upon them are particularly interesting and full of useful information. They are mostly very fully illustrated.

*

Gas Producers for Power Purposes. BY W. A. TOOKEY. London: Percival Marshall and Co., Poppin's Court, E.C.

This little book is a useful introduction to a more extended study of this important subject and is also especially intended to give reliable information to non-technical purchasers of, to erectors who instal, and to the attendants to whose intelligent care such a plant is entrusted.

In the earlier and major part of the book the subject is treated generally, the better known producers being illustrated and their action explained and several useful hints as to the starting and subsequent operation of producers given. In the latter part or appendix most of the producers on the market are illustrated and explained in detail.

*

Motors and Motoring. By Hy. J. Spooner, M.I.Mech.E. London: T. C. and E. C. Jack, 34, Henrietta Street, W.C., 1905.
Petrol Motors Simply Explained. By T. H. Hawley. London: Percival Marshall and Co., Poppin's Court, E.C.

Both are well-written elementary little books which explain clearly the general principles on which all petrol motors are constructed. Mr. Spooner's book is larger and explains the subject more fully than does Mr. Hawley's book, which is more particularly devoted to cycle motors and the "F.N." cycle motor in particular. The plan of the books is the same, both give a simple explanation, illustrated with diagrams of the Otto cycle followed by illustrated descriptions of the principal parts of the illustrated motor.

Mr. Spooner's book forms an excellent introduction to the mechanics of the petrol motor car, and after reading it one has a good idea of best known carburettors, sparking plugs, silencers, transmission gears, clutches, &c., as well as of ignition and lubrication. The illustrations in this book are also very clear.

*

Beginners' Guide to the Lathe. By Percival Marshall, A.I.Mech.E. London: Percival Marshall and Co., Poppin's Court, E.C.

This is No. 25 of the Model Engineer Series. It is quite an elementary work, but nevertheless an admirable guide to the working of the amateur's hand lathe, and a perusal of it will save most of the time that is usually spent in learning by experience and prepare the beginner for more advanced books on the subject.

*

Books Received.

The Mechanical Handling of Material. Being a treatise on the handling of material such as coal, ore, timber, etc., by automatic or semi-automatic machinery, together with the various accessories used in the manipulation of such plant, also dealing fully with the handling, storing and warehousing of grain. By Geo. Frederick Zimmer, Assoc. M. Inst. C.E., with 550 illustrations. London: Crosby, Lockwood and Son, 7, Stationers' Hall Court, Ludgate Hill. 1905. [521 pp.; 10¼in. x 7¼in. and several folding plates; price 25s. net.]

Modern Engines and Power Generators. A practical work on prime movers and the transmission of power steam, electric, water and hot air. By Rankin Kennedy, C. E. With 254 illustration. Vol. V. London: The Caxton Publishing Co., 84-86, Chancery Lane, W.C. [216 pp.; 10¼ ins. x 7¾ins.; cloth, price 9s. net.]

Journal and Report of Proceedings of the Institution of Permanent-Way Inspectors. Vol. XXIII. Part I. Edited by Clement E. Stretton. London: Published by the Institution, 9, Gracechurch Street, E.C. 1905.

Railway Companies and Traders. Owner's risk conoitions.
Report of the Standing Joint Committee of Midland Chambers of Commerce on Railway Matters respecting their negotiations with the Great Western, L. and North Western, the Midland, and the North Staffordshire R. Companies, with regard to the interpretation of their "Owner's Risk Conditions," and the treatment of claims thereunder for loss, damage, or delay.

The Maintenance and Strengthening of Early Iron Bridges.*

This paper deals first with the strengthening of an iron bridge over the River Ouse, consisting of three spans of 117ft., and two end spans of 70ft., the reinforcements consisting of extra plates to increase the flange-area and provide extra rivets for the braces, new cross girders and flooring. The bridge was thus brought up to modern requirements at a cost of some £8,000.

Next is given a description of the strengthening of a bridge over the River Thurne, consisting of three spans of 79ft. each, which necessitated extra plates at all panel-points to give extra rivet-area, new cross girders and longitudinals, and re-arrangement of flooring. The whole of this work was done while traffic was running, at a cost of about £2,050.

A method of reducing the stress in old bridges by reducing the permanent dead load is also dealt with, and an example is given.

The author states the difference, from a maintenance point of view, between iron and steel, and records the experience of over twenty years in the preservation of bridges, etc., from rust; after describing various methods, he ends by recommending the use of Portland cement for the purpose, giving examples of its use.

* Abstract of a paper by Mr. W. Marriott read before the Institution of Civil Engineers, April, 1905.

Bowman's Either-side Brake for Wagons.

This brake is a South Australian invention designed to comply with the conditions laid down by the Board of Trade and Railway Clearing House Committee. It is applied or released from opposite or diagonal corners of the vehicle by the side levers now in use, and which are fixed upon a brake shaft. These brake levers are supported in a raised or "off" position by movable spring supports placed inside the guides, and connected by rods to a rocking shaft, which is carried in bearings attached to the under frame.

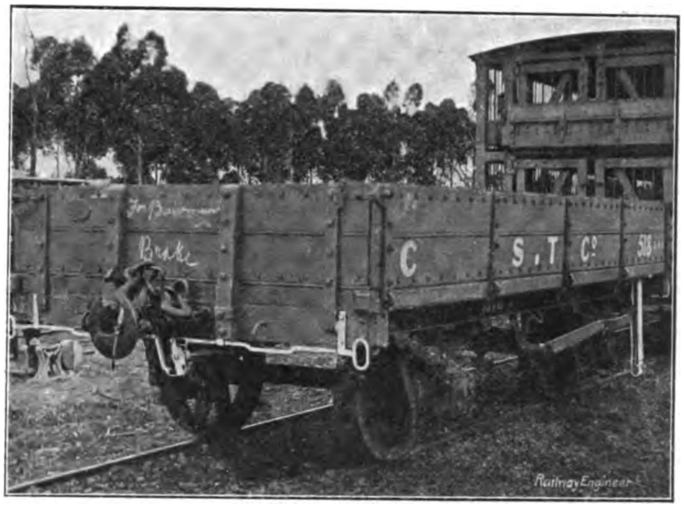


Fig. 1.

Draw rods with handles are placed at each corner of the vehicle, and connected to arms on the rocking shafts, so that assuming the two hand levers to be in the raised position, corresponding to the "off" position of the brake, by pulling any one of the four draw rods with handles, 1½in. outwards, the two movable supports can be withdrawn from under the hand levers, which will then fall and apply the brake.

The shunter, when applying the brake, stands clear of the vehicle (fig. 3), and if he should miss the first handle he might apply the one at the other end of the truck. To release the brake either hand lever is raised sufficiently high to allow the springs to push the supports out under the brake levers.

The application and release require one motion only, and only one hand is required for either operation.

The Bowman brake is also suitable for hopper trucks and bogie trucks, and can be made to apply the brake to all the eight wheels from any corner. It has been reported on favourably by

the experts of the South Australian Government Railways, Silverton Tramway Co., and Broken Hill Proprietory Co. It has been tried successfully by the Silverton Tramway Co., by the Broken Hill Co. (where they have some very steep gradients), and has also been running (in a slightly modified form) for three

Fig. 2.

years without a single complaint on the Iron Knob line, belonging to the Broken Hill Proprietory Co.

Mr. Robert W. Goudie has a full-sized working model erected at 35, Walbrook, E.C., which he will be pleased to show to anyone interested.

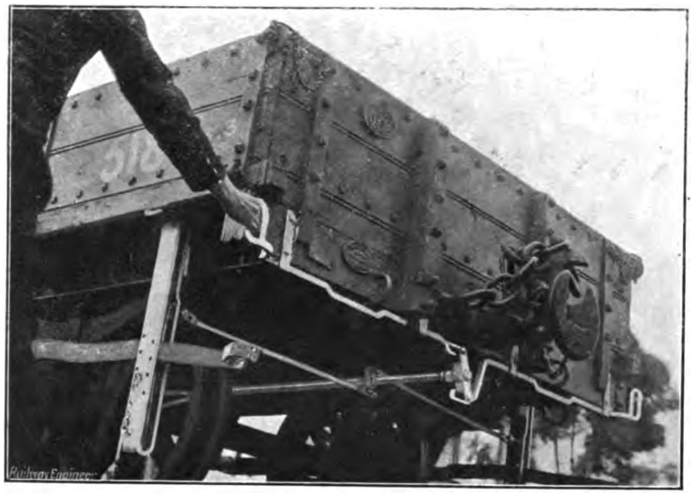


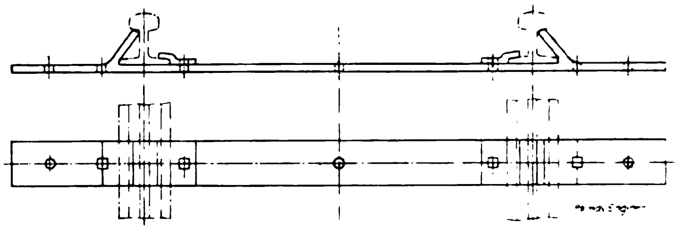
Fig. 3.

It is estimated that the cost of this appliance, including fitting, will be less than £2 per truck.

Fig. 1 shows the brake in the "off" position, fig. 2 the reverse end of the same truck, and fig. 3 the method of application. It will be noticed that by pulling the one handle the other three are not disturbed.

North's Patent Rail Tie.

On some light railways where flange or Vignole rails are laid trouble has been experienced owing to the rails spreading, particularly on very sharp curves, and with the object of preventing this the tie, illustrated by the annexed drawing, has been devised by Mr. North, the agent in charge of the North Wales Narrow Gauge R. at Denis Junction.



It consists of a flat bar about 4ins. wide, having projections which butt under the head of each rail, and provided with loose clips bolted on and which secure the inside flange to the tie as shown in the illustration. The ties are easily made and readily put in position, and we understand that the results have been entirely satisfactory on the above railway, which abounds with frequent and sharp curves.

Messrs. Davies and Metcalfe, of Romiley, are the makers, and further particulars can be obtained from them direct or from their London office at 75, Finsbury Pavement, E.C.

Rolled Steel Wheels.

The increased carrying capacity of American freight cars taxes the chilled cast-iron wheels beyond the limit of their endurance. This is largely due to the fact that, owing to the limitations imposed by the permanent way, the flanges cannot be enlarged so that the wheels placed under cars of 100,000 lbs. capacity are not nearly so strong as those used under cars of 60,000 lbs. capacity. The heating caused by power brakes is also very trying to cast-iron wheels.

Mr. Samuel M. Vauclain, in a paper lately read before the Franklin Institute at Philadelphia, described a new Rolled Steel Wheel which will apparently successfully compete with the chilled cast-iron wheel, and which will, we should think, be used far more widely.

This wheel is made from high carbon steel. The ingot is cut into blanks sufficiently large to make one wheel. The blanks are taken from the furnace and pressed into shape under a 5,000-ton hydraulic press, and from there transferred to the rolls and subjected to enormous pressure and revolved at a high rate of speed, emerging as finished wheels. The blanks are handled entirely by mechanical means.

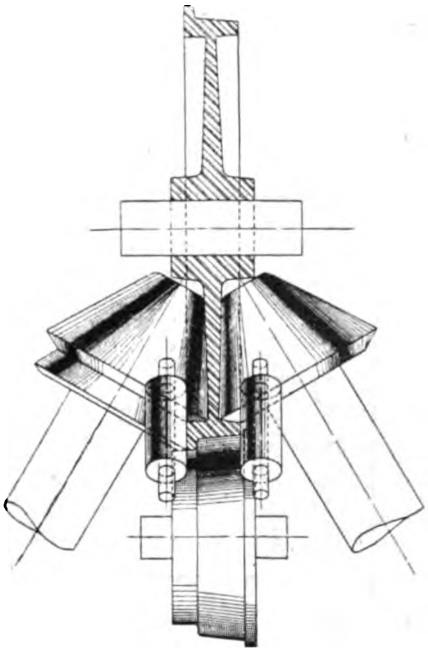
The method of rolling and arrangement of rolls is shown in the diagram, from which it will be seen that the arrangement is such that thorough and heavy work can be put on the tyre of the wheel.

The wheel may be dished or curved by placing it in a 500-ton press and gently squeezing it into shape.

Analyses indicate the greatest uniformity in the wheel. Tests have also been made by supporting the wheels horizontally upon a ring underneath the face of the tread and allowing a weight of 2,240 lbs. to strike the wheel from various heights. It took thirteen blows to break a 36in. wheel, eight of the blows being from a height of 30ft.

Another wheel was tested in running position, and striking with a weight of 2,240 lbs. it took seventeen blows, nine of them being from 25ft., to fracture the wheel from rim to hub.

One of the most severe tests that can be imposed upon the chilled iron wheels is, Mr. Vauclain remarks, that generally known as the thermal test. This consists in pouring a ring of molten iron 1½ins. thick and 4ins. deep against the tread,



no cracks to develop within two minutes. This test is designed to secure a wheel which will not crack by the heat developed by the application of the brake shoes, and it is considered by manufacturers of chilled iron wheels to be a very severe requirement. A number of rolled wheels have been subjected to this test without injury to them. The heat from a ring of metal 4ins. wide in place of 2ins. had no further effect than to cause the rim to expand and to draw the hub down slightly. No fracture was produced and the heat given out by the molten iron was sufficient to heat the tread for 2 or 3ins. to a dull cherry. After withstanding this test there need be no fear of breakages as the result of heating of the tread by application of brake shoes.

The comparison of the cost per 10,000 miles of the two types of wheels is given by Mr. Vauclain as follows :—

SOLID ROLLED WHEELS.

Cost of pair of rolled wheels	$54·00
Cost of four turnings	2·40
Cost of four removals and applications	2·40
	$58·80
Less scrap value	8·75
Net cost	$50·05

Mileage, 350,000.
Cost per 10,000 wheel miles, $1·43.

CHILLED IRON WHEELS.

First cost of pair of chilled iron wheels	$18·00
Cost of boring and mounting	·80
Cost of removal and application	·60
	$19·40
Less scrap value	5·80
Net cost	$13·60

Mileage, 80,000.
Cost per 10,000 wheel miles, $1·70.

It is usual for the railroads to determine the average cost of wheels by dividing the total yearly cost by wheel mileage made during that year. The statistics vary from 1·65 to 1·78, the average closely checking the foregoing estimate.

The natural field for the rolled wheel is :

1. The severe service of engine and tender trucks, in which steel-tyred wheels are now exclusively used.

2. Passenger car equipment, in which the element of safety plays an important part.

3. Heavy freight car equipment, for which the chilled iron wheel has proved inadequate.

The wheels, however, are adaptable to lighter service, and statistics indicate that it would be profitable to employ them in street car service.

The following statement shows the cost of maintenance of wheels in street car service in various part of the United States. These figures are practically based upon the use of the usual type of chilled wheel :—

	Per 10,000 miles.
North-western	$1·61
Pacific coast	1·15
Middle-west	2·14
Chicago	3·04
Canadian	3·04
Philadelphia	1·65

The railways carrying the greatest number of passengers will generally show the greatest cost, as the constant braking necessary because of frequent stops and slipping resulting from rapid acceleration is very hard on the chilled iron wheel. By the rough usage at many crossings many wheels are put out of service by clipping off the flanges.

Atlantic or 4-4-2 Class Engines; Great Western Railway.

THE new Atlantic or 4-4-2 class of engines which Mr. G. J. Churchward, M.Inst.C.E., has recently designed for the Great Western R. are illustrated by the annexed diagram. Several of these engines are now at work, and have given satisfactory results.

The engine "Albion," which we illustrated in our issue for April, 1904, has been altered as shown in the illustration, but it must not be assumed that the 4-6-0 class has been abandoned, as there are four or five other 6-coupled express engines in constant work with the heavy express services.

The principal dimensions of these engines are :—

Cylinders, 18ins. diam. by 30ins. stroke: steam ports 31½ins. by 1¾ins.; exhaust ports 31½ins. by 4¼ins.

Boiler, barrel 14ft. 10ins. long by 4ft. 10¾ins. and 5ft. 6ins diameter outside; firebox outside 9ft. long by 5ft. 9ins. and 4ft.; firebox inside 8ft. 2 3/16ins. long by 4ft. 9ins. and 3ft. 2¾ins.; firebox height 6ft. 6 7/16ins. and 5ft. 11/16ins.; 250 tubes 2ins. diam. by 15ft. 2 5/16ins. long.

Working Pressure. 225lbs. per sq. inch.

Heating Surface, in the tubes 1988·65 sq. ft., in the fire box 154·26 sq. ft., total 2,142·91 sq. ft.

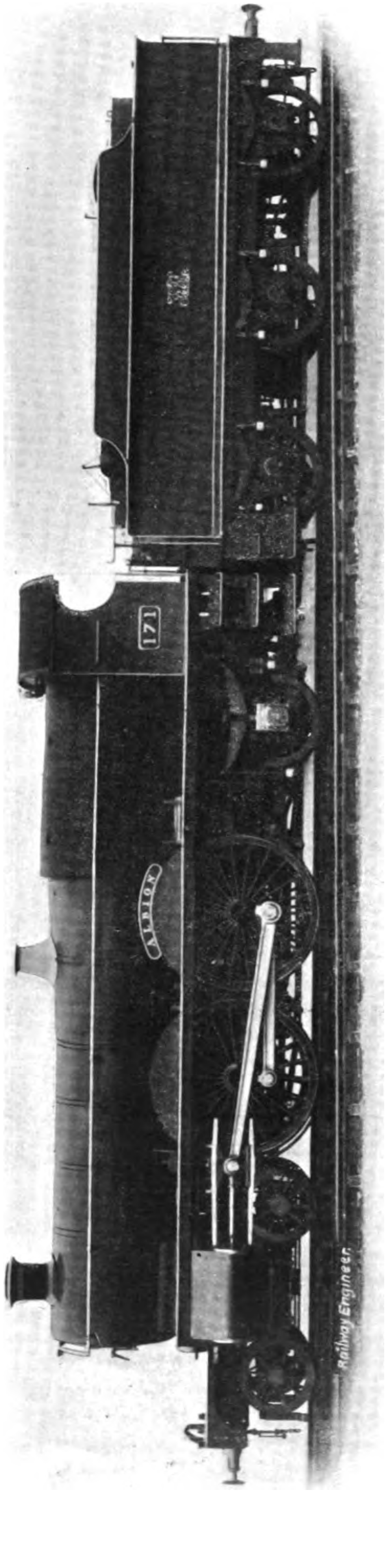
Fire Grate, 27·07 sq. ft.

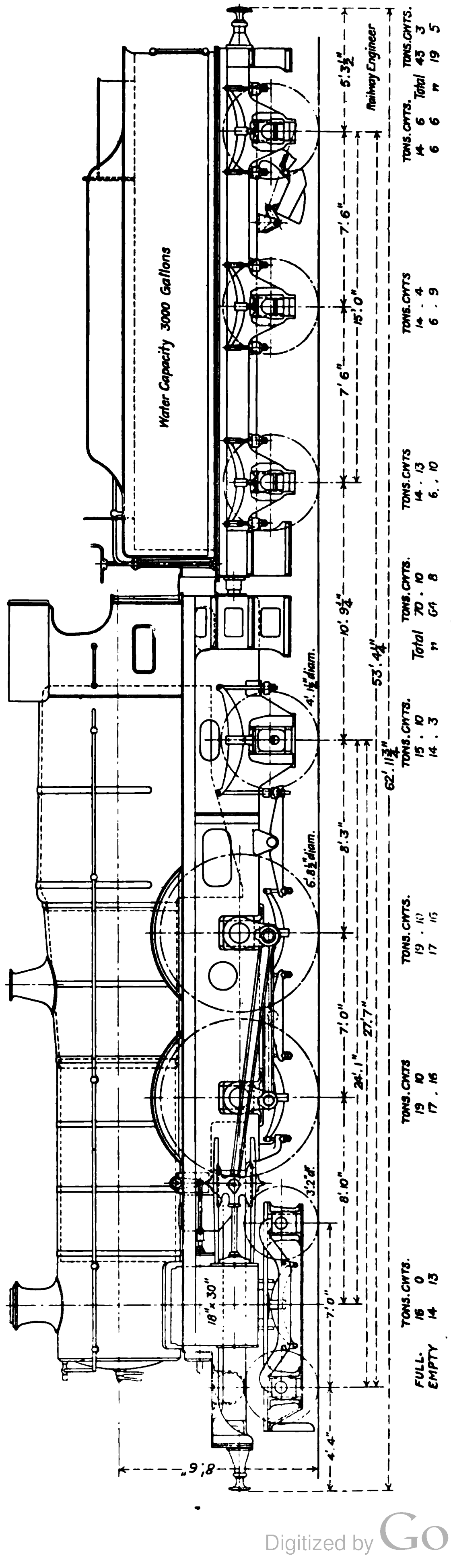
Wheels, coupled 6ft. 8½ins. diam.; bogie 3ft. 2ins. diam.; trailing 4ft. 1½ins. diam.

Weights	Working Order	Empty
On the bogie wheels	16 tons 0 cwt.	14 tons 15 cwt.
On coupled wheels	19 „ 10 „	17 „ 16 „
On driving wheels	19 „ 10 „	17 „ 16 „
On trailing wheels	15 „ 10 „	14 „ 3 „
Total	70 „ 10 „	64 „ 8 „
Tender	43 „ 3 „	19 „ 5 „
Total	103 „ 13 „	83 „ 13 „

Water, capacity of tender tanks 3,000 galls.

Tractive Force, 24,450lbs.





Atlantic or 4-4-2 Class Engines; Great Western Railway.

Reinforced Concrete in Railway Construction.

THERE seems to be a very remarkable diffidence on the part of English railway engineers to accept the fact that Armoured or Reinforced Concrete has come to stay, and, notwithstanding the great and increasing use of this material in America and on the Continent of Europe, it appears to have made comparatively little progress in Great Britain or our Colonies.

The most interesting paper that has been given in this country on the subject was given before the Institute of British Architects, and not, as it should have been, before the Institution of Civil Engineers, where the matter is conspicuously left severely alone. Something was done when certain members of the English Institution met other members of the American Society at the St. Louis Conference, but beyond a paper read before the Liverpool Engineering Society in 1900, and a paper read by Mr. A. T. Walmsley before the British Association at Bradford, also in 1900, nothing in the way of learned papers on the subject has come under the notice of the writer.

Of course, the appearance of the material is against the extensive use of it, but even in this aspect of the question it seems strange that little has been done in this country to grapple with this defect. The tendency when dealing with concrete, whether reinforced or not, is to treat it in large blocks with extensive flat surfaces, such as is found in sea walls, etc., but seeing that the material is capable of being moulded and broken up into ornament such as strings and panels, dentils and projections, it does not seem to be essential that the flatness of surface, so invariably seen, should be retained in the case, say, of bridge abutments, wing walls, parapet walls, pilasters, and walls of buildings.

In fact, a concrete (armoured) bridge at St. Louis, the New Forest Park Bridge of the Wabash RR., is a very fine example to emulate in this respect. The abutment and wing walls are well panelled, and the latter are curved to a most exquisite line. The pilasters are well designed with ornaments of shields and foliage, and the parapet over the flat headway of the bridge is beautifully broken up into intermediate blocks supporting urns, filled in between with circular balusters.

It appears very probable that in the use of reinforced concrete, except in the case of arched bridges, the girder will not be done away with, at least in the immediate future. The use of the material in railway bridges in which the headway is at all restricted appears to be more in the way of flooring laid between or resting upon the girders, than its use in the actual girders themselves. There is, of course, little doubt but that a reinforced concrete girder of ample strength could be devised, with perhaps (fig. 1) many horizontal or flatly curved rods or bars, with some vertical or inclined bars to bind the whole together as a practically homogeneous mass and ensuring uniformity of resistance under the loads; but it appears that such a girder can only be adopted where there is no restriction in the headway or in the permissible dead weight.

It is even within the bounds of possibility for a lattice girder to be designed in which the various triangulations are made up of several bars of steel within a concrete mass, as in the case of a peculiarly shaped steel-concrete girder at Purfleet, but it is very questionable whether such constructions will be used by English railway engineers for some time to come.

The probability is that if this type of construction be used at all it will be in the form of the bedding and surrounding of a properly and independently made structure or truss, with all the connections properly riveted and finished and acting as a chord or stiffening inside a protecting and surrounding composition of a very adhesive but not brittle concrete.

In this case, even if the different bars and chords of steel are not made strong enough in themselves to carry the stress to which they will be subjected, it is nevertheless probable that the riveting and connecting of the various parts will be of ample strength independently of the concrete covering such connections. The advantage gained in this case will be that of greater stiffness and solidity in the bridge and of the total exemption from the heavy charge for painting and maintenance to which ordinary steel bridges are subject.

The lattice girder previously referred to (at Purfleet), with its peculiarly designed struts and ties in the web part of the structure, is an example that it is unlikely will ever be copied, the different parts being not very rationally designed to carry out the functions which they would have to undertake in a structure designed to carry the ever varying exigencies of railway moving loads.

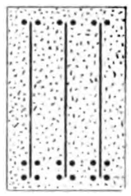


Fig. 1.

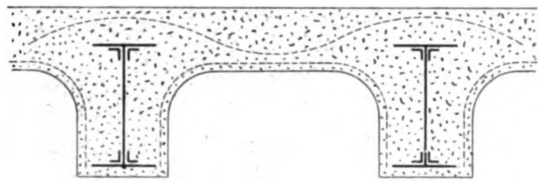


Fig. 2.

In the case of railway underbridges the simplest type of bridge is that of longitudinal girders under the rails, perhaps one steel girder under each rail, with jack arches between them. For this design the obvious thing would be to replace the usual brick jack arch with concrete jack arches, with possibly a few rods just above the intrados of the arch to keep the arch from cracking under the vibrations to which it is subject. In this case something will have to be designed to carry a layer of concrete or cement one or two inches in thickness on the underside of the girders themselves, and so avoid painting charges. A web of expanded metal attached by the riveting would perhaps serve the purpose.

The next thing after the replacing of the jack arches would be to lighten the structure by raising the haunches (fig. 2), and in this case the steel rods will become more necessary than in the example of the arch of circular section. A certain part of the structure, midway between the girders, will have perhaps to resist bending as well as vibration.

A more complex design is that where there are main girders and cross girders, and in this case perhaps the use of reinforced concrete will enable the cross girders to be placed further apart, and the jack arches, whether circular, elliptical, or flat, to have a longer bearing. In this way cost may be saved and dead load decreased by the use of this material,

but in this case it will probably be necessary to make the floor strong enough to carry a sleeper with its load of chair, rail, and axle-weight, at any point between the cross girders.

In the case of the still more complex railway underbridge with main girders, cross girders, and rail bearers, the use of reinforced concrete will be again in the floor, and an adaptation of the expanded metal system may perhaps be arranged, which, although necessitating a floor heavier than the usual $\frac{3}{8}$in. floor plate, with its cross stiffeners, yet will gain much by the doing away with the painting and costly maintenance always so necessary in this type of structure.

In districts where chemical fumes are found so destructive to any kind of ironwork, a floor of this material would be a great and manifest advantage, since the whole of the metal surface would be covered with at least some appreciable thickness of concrete, through which the exceedingly deleterious fumes could have no effect.

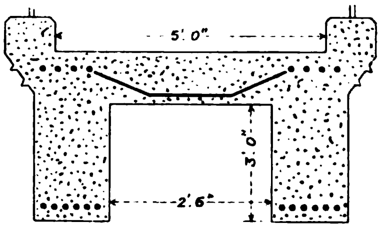


Fig. 3.

The footbridge at Toulouse (fig. 3) forms an admirable example of what could be done in this material for some of our station footbridges, and in fact for other bridges made to carry footroads or light loads across lines of railway. In this design there would be no need for ever watchful care to prevent oxidation of steel lattice girders under the constant attacks of sulphurous fumes from the engines, aided in their destructive influence by the dampness of the condensed steam from the engines.

In skew bridges, where the bridge superstructure has to be built at an angle with the abutments, all the trouble arising from the necessary cutting of the skewbacks to elaborate geometrical drawings, the trouble incidental to the working of the bricks or stones composing the arch in their requisite spiral courses would be done away with, and a solid homogeneous structure would replace the arched bridge of to-day, which is only too liable to crack or to fail in other ways.

Of course, as regards arched bridges, where there is ample depth for construction and no necessity for a flat or thin form of construction, the use of reinforced concrete is at its best. Combining tensional strength with the monolithic nature of the brick arch, there would not be the same fear of settlement and cracks that now exists in all such work. It is probable that the unsightly protuberances of cast iron face plates, with the accompanying obnoxious nuts of the tie-bolts so often seen in cracked railway bridges, would not be so often noticed as they are at present, when failures in brick and stone arches are so numerous.

In the use of reinforced concrete for arched railway bridges (fig. 4) there would be another advantage, a flatter curve could be adopted, and an economy in headway provided, a matter often of the very first importance in both new lines and in the extension of old railway bridges. In many such cases, where the widening of an old line has to be negotiated, the local authority seldom fails to insist that the underbridges shall be widened as well as extended at the same time that the headway is retained, mostly a costly operation, involving the use of steel girders and great cost in future maintenance, but with the use of this comparatively new material the case may often occur where the distance between the abutment of an old bridge might be widened and at the same time the arch made with a flatter curve, thus obviating great expense.

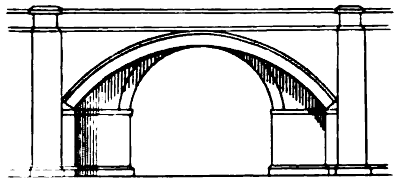


Fig. 4.

In the construction of arched bridges of reinforced concrete there are many examples, such as the 54ft. 3ins. arch carrying two main tracks of the Central Railroad of New Jersey across Jackson Street, Newark, U.S.A., for the railway engineer to fall back upon as a precedent.

There are many cases met with in strengthening old railway bridges where cross girders are found to be weak for modern heavy engines, whilst the main girders are amply strong. In this case a few steel rods, covered with concrete and forming a ferro-concrete floor, would suffice to provide a stronger floor by distributing the effect of the moving load over the whole or a greater surface of the floor.

For retaining walls the use of the material under consideration may be very happily adopted. Many retaining walls in railway works have given great trouble with their unequal and inexplicable settlements, failure of substructure, cracks and movements downwards and forwards. Especially is this the case where the wall is built on unsafe and unsatisfactory ground such as is found in many heavy cuttings such as those in the counties of Leicester and Northants, where the treacherous ground both below and all the way up the slopes are constantly giving anxiety and trouble. A judicious use of carefully and scientifically arranged bars of steel in a concrete wall would often meet the case, and, whether it prevented failure or not, could be made to act as a girder both laterally and vertically, a consummation that cannot be effected in brickwork, however well designed. Whether the case of defective foundation would be fully met or not, it is certain that the usefulness of the wall would be enhanced.

In cut and cover work in railway subway and tunnel building the Vienna Metropolitan Railway forms a good example, as do the Dunham Subway, the Battery Park Subway, New York, and the Boston and Philadelphia Subways in the States. In this kind of work it is next to impossible to keep the steel girders, if such are used, in good condition by painting or tarring them, the constant presence of smoke and steam militating against any preservative applied to the surface of the metal, and if jack arches are used the underside of the girder is still exposed. The reinforced concrete beam will here entirely meet the case, and entail no future maintenance.

Ferro-concrete piles could be used under the piers and abutments of bridges, under retaining walls, under dock walls, and under heavy warehouses. Such piles, in which vertical rods are surrounded with fine concrete, sometimes held together by transverse bands, are able to take much greater loads than the ordinary wood piles used in such situations. The ferro-concrete piles are practically indestructible, and in relation to the safe load are cheaper than timber.

But it is perhaps in warehouses and dock sheds, granaries and bonded stores, of which a great number are owned by railways, that the adoption of reinforced concrete would be of the utmost service. Higher and stronger walls, considerably thinner than if built of brick and stone, and yet far stronger, are with ease erected in this material in the States and in other countries; the floors are stronger to carry the loads of corn or other merchandise, when formed of expanded metal, and occupy far less room on account of their comparative thinness. The maintenance charges are practically nil, and above all the risk of fire, with its attendant compensation to the traders, is obviated. If it should be that a wagon loaded with heavy goods gets astray and knocks against the warehouse wall, the resistance to the shock is greater, and many cases have been cited, notably in the discussion of the paper before the Institute of British Architects, in which monolithic structures of reinforced concrete have been severely handled in cases of accident, and yet little damage has occurred.

We have already referred to the use of expanded metal in floors, but it is equally applicable to roofs where slabs of the material can be laid on the steel framework without the costly and fire-inviting framing of timber purlius, rafters, and boarding, which are essential to good work in the case of slate or tile roof coverings. A notable case is that of the receiving station of the United States Express Co., New York, where the roofing on the principals consists of slabs 4½ins. thick in spans of about 10ft.

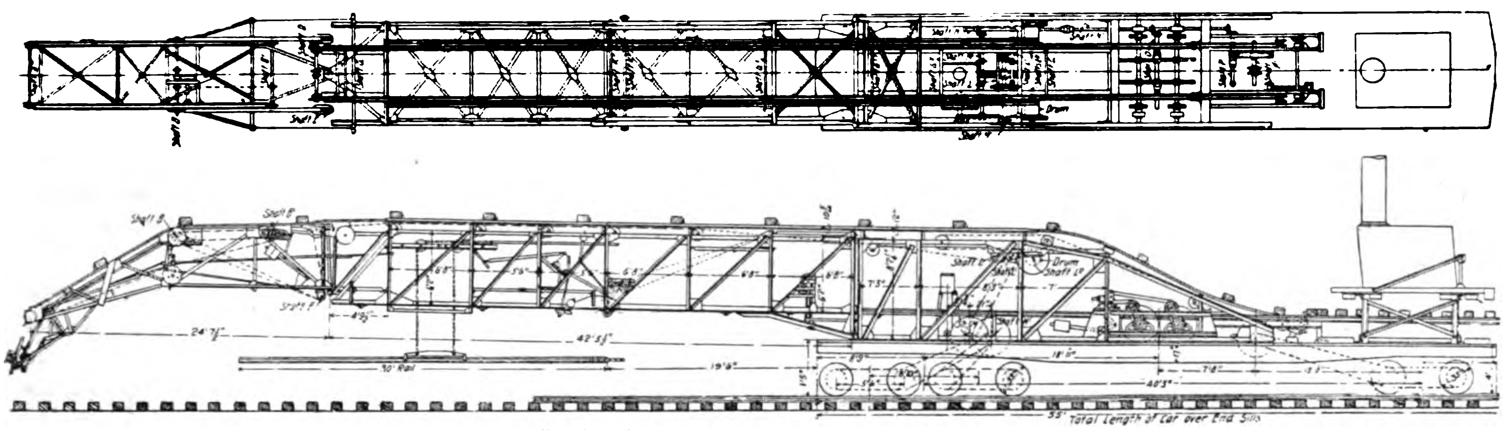
For underpinning, as for example in the case of the steel-concrete girder under the Old State House for the Boston Transit Commission, the use of reinforced concrete is most advantageous, and a stronger but indestructable girder can be erected in position, spanning over distances ordinarily necessitating a steel girder, and the reinforced concrete girder can be adapted to carry both tension and compressive stresses with facility. In many cases of this sort it would be a very difficult undertaking to place a steel girder in position, whilst to build it up from plates and bars on site would be impossible.

But even as ralway sleepers it has been suggested that this material could be used, with what success it is perhaps premature to discuss. If a sleeper of this material could be devised, which would be practically independent of climatic influences and incapable of rotting, notably in the case of dark, damp smiking tunnels, it would be a great boon to our railways.

The Hurley Track-laying Machine.

THE Hurley track-laying machine consists of a "machine car" with a 67ft. cantilever extension for carrying sleepers in advance of the material train, and with power-driven rolls for hauling strings of rails over the material cars to the front of the work. The accompanying illustration, reproduced from a drawing, shows the general appearance of the machine car and whole outfit of gear and materials. The machine car furnishes the motive power, not only for the conveyance of track materials, but also for moving the train, so that the service of a locomotive is dispensed with. This is one of the large factors in the economy of the use of this type of track-laying machine.

The cars loaded with sleepers are coupled in behind the tender of the machine car, the cars loaded with rails bringing up the rear. At the middle of each material car, on each side and about a foot inside the edge, there is a roller, used



Details of the Hurley Track-Laying Machine.

for moving the rails ahead. The rails are coupled up with two bolts in each splice and are pulled forward over the rollers in two lines, one on either side of the train. On the sleeper cars the lower tiers of sleepers are laid lengthwise the car and clear of the rollers, so that there are open spaces for the rails to pass underneath the sleepers that are piled crosswise. On the machine car each line of rails passes between two sets of steam-driven friction rolls, which drive them forward and also pull the whole string of rails behind. As each string of rails is fed forward to the machine car, rails are coupled on behind at the rail cars at the rear of the train.

The sleepers are carried forward on the two lines of rails. At the front end of the first sleeper pile back from the machine car, the ties are rolled down and laid across the rails roughly spaced at the same intervals as they are laid in the track. As the rails move forward they therefore convey all the ties necessary to lay them. The line drawing illustra-

tion shows the machine car, with the rails and ties as they appear when moving forward over the train. As the sleepers arrive at the machine car they are caught on an endless chain and conveyed up an incline over the top chords of the cantilever extension, and as they arrive at the front end of this they slide down an incline and fall upon the road-bed crosswise the alignment of the track. In this manner they drop approximately to place, and it is only necessary for two men to square them around and properly space them. In this way the roadbed is constantly supplied with sleepers in advance of the laying of the rails.

The trusses of the cantilever of the machine car stand 8ft. clear of the roadbed, or high enough to allow free action of the spikers underneath. Attached to the bottom chord of each truss there is a channel, in which are power rollers for moving the rails forward. As the rails arrive at the front of the machine car they are uncoupled, one at a time, by taking out the rear bolt at each joint, leaving a pair of fish-plates loosely coupled to the rear end of each rail. A rail on each side is then sent forward under the overhang to a point about 20ft. ahead of the machine car, where it is grasped by a pair of hoisting tongs and lowered by one man on to the sleepers below, as seen in the line drawing. In dropping the rail to couple on at the end of the last one laid, it is lowered to within about 2ins. of the rail already laid, and when the car has moved it nearly to place the heeler swings it ahead 1½ or 2ft., so that the rail is dropped an instant before the car has moved far enough to place it there if it was dropped vertically. The operations are so gauged that the rail is set down just about a foot in advance of the last rail laid and spiked. The rail is then pulled back by the track layers, and quickly coupled on. To facilitate the work of getting the fish-plates home, use is made of a U-shaped clamp worked by a lever and eccentric. This tool quickly forces the fish-plates to a fit and brings the ends of the rails into line before the bolt is tightened. Meanwhile the quarters and centres of the rails are spiked and everything is then ready for coupling on another pair of rails. The length of the overhang is such that the rails for the two sides of the track can be set down in pairs when laying with either square or broken joints.

The train moves gradually forward at the rate of 20 to 30ft. a minute, and with experienced track layers it is not necessary to stop. With inexperienced men a brief pause is made each time a pair of rails is disconnected. The machinery is so geared that the material is moved forward over the cars at exactly the same speed that the train moves over the track. The rollers on the overhang are driven about five times as fast as the main feed rollers, so that there is no trouble in keeping the front end of the machine car cleared for action. When track is being laid on curves the incline at the front of the cantilever is swung laterally enough to land the sleepers on line.

The machine, which is owned and operated by the Hurley Track-Laying Machine Co., Syracuse, N.Y., has recently been used on the Chicago, Cincinnati and Louisville R.R., and on the Pittsburg extension of the Wabash R.R. With a force of 60 men the machine will lay and quarter-spike 20,000ft. of track in a day. The company is now engaged on the construction of new machines which are designed with certain improvements intended to reduce somewhat the number of labourers required with the present outfit.—*Railway and Engineering Review.*

The High-Speed Vacuum Automatic Brake.

In our October issue we announced that the Vacuum Brake Company, Ltd., were prepared to supply high-speed brakes, and we are now able, by the courtesy of that Company, to illustrate in detail the arrangement of the fittings, which, it will be seen, is very simple and does not require any extensive alterations to existing brake arrangements.

The New Patent High-Speed Brake has been working on express trains for more than twelve months, and has given complete satisfaction.

Stops made with it are at least 25 % better than are made with the ordinary brake.

It is the invention of Messrs. Gresham and Craven, Ltd., of Salford, Manchester, who are the sole manufacturers for the Vacuum Brake Company, Ltd.

As its name implies, the High-Speed Vacuum Automatic Brake is intended for use on express passenger trains, which now attain very high speeds and are generally composed of a number of heavy vehicles.

When trains are travelling at a high rate of speed the pressure of the brake blocks on the wheels may be from 100 to 120% of the pressure between the wheels and the rails at the time of the initial application, but the brake block pressure must be eased off automatically as the speed of the train decreases.

To attain this result the Vacuum Brake Company have adopted the arrangement illustrated by fig. 1, which shows the complete apparatus (including the rapid-acting valve) for a carriage, the details of which are as follows :—

The cylinder, fig. 2, does not differ materially from the "C" pattern now in general use. The piston is packed by the well-known rolling ring.

In place of the ordinary ball-valve the new High-Speed Ball Valve is bolted on to the bottom of the cylinder. Fig 3 is a sectional view of this valve in the "running" position. The passage *a* is in communication with the bottom of the cylinder and the train pipe; the passage *b* is connected with top of the cylinder and vacuum chamber. The underside of the diaphragm *i* is in connection with the atmosphere through the holes *c*.

When the brake is applied air enters the passage *a* on its way to the underside or brake cylinder, and also finds its way into the vacuum chamber through the annular passage *d* and the holes *e* and *f* as indicated by the arrows.

When the vacuum in the vacuum chamber and on the top side of the diaphragm has been reduced to a predetermined amount the spring asserts its power, and causes the hollow spindle *g* to descend. This movement allows the ball to seat on its fixed seating and prevents any further reduction of vacuum in the chamber and space above the piston. Fig. 4 shows valve in this latter position.

The period of leakage is governed by the size of holes *e* and *f* in the hollow spindle *g*, and the spring working in conjunction with the diaphragm *i* arrests this leakage at any desired amount.

It will be seen, therefore, that when an emergency application of the brake is made full power will be exerted by the cylinder and that this power will be gradually reduced as the train comes to rest.

In case of emergency an instantaneous application of the brakes on a train is obtained by means of the Rapid-Acting Valves illustrated by fig. 5. This valve is mounted directly on the train pipe and connected to the cylinders, *viâ* the Ball Valve, figs. 3 and 4, as shown in fig. 1.

The normal or "running" position is shown by fig. 5. A vacuum is maintained on the underside of the valve *a* and the top side of the diaphragm *b*; the atmospheric pressure being free to act on the top side of the valve *a* and the underside of the diaphragm *b*, but on account of an excess of pressure the valve *a* is held tight upon its seating.

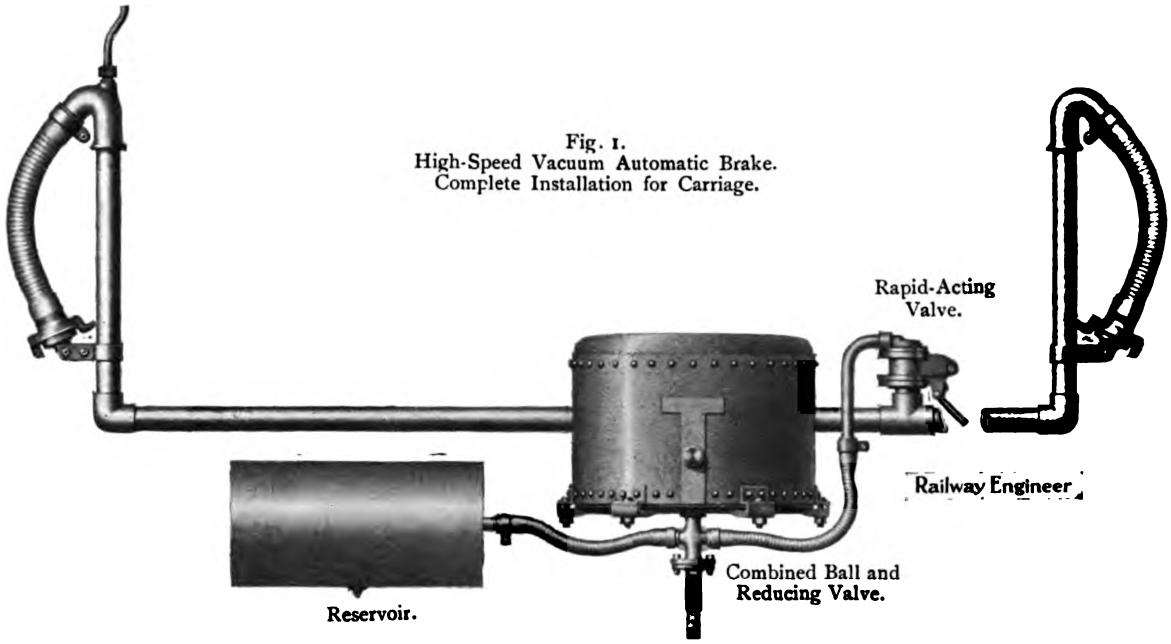


Fig. 1.
High-Speed Vacuum Automatic Brake.
Complete Installation for Carriage.

When a "rapid" action of the brake is required air is suddenly admitted to the train pipe, and thus to the underside of the valve *a*; the pressure acting on the underside of the diaphragm *b* is then sufficient to cause it to lift the valve *a*, and allow air to pass full-bore both to the brake cylinder and to the train pipe. See fig. 6. Immediately the brake is "full on" the valve falls to its normal position by gravity.

In graduated or ordinary service applications of the brake air in moderate quantities is admitted to the train pipe, and the area of the annular passage around the peg *c* is so proportioned that it will allow the necessary amount of air to enter the brake cylinder, and so obtain a simultaneous action of the brake on every vehicle throughout the train.

The clappet *d* performs three functions :—

1. It prevents dust accumulating in the valve casing, keeping it perfectly clean, as it always rests on its seat, as shown by fig. 5, except during an emergency application.

2. In case of leakage either in the diaphragm or seating the clappet can be shut down by means of the lever *e* and thus an air-tight brake is ensured until such time as the valve can be attended to.

3. It allows of the brake being used either as a "rapid-acting" or an "ordinary" vacuum automatic brake. In the former case the clappet valve *d* is free to work, as shown in fig. 6, and in the latter the valve is held upon its seat by means of the lever.

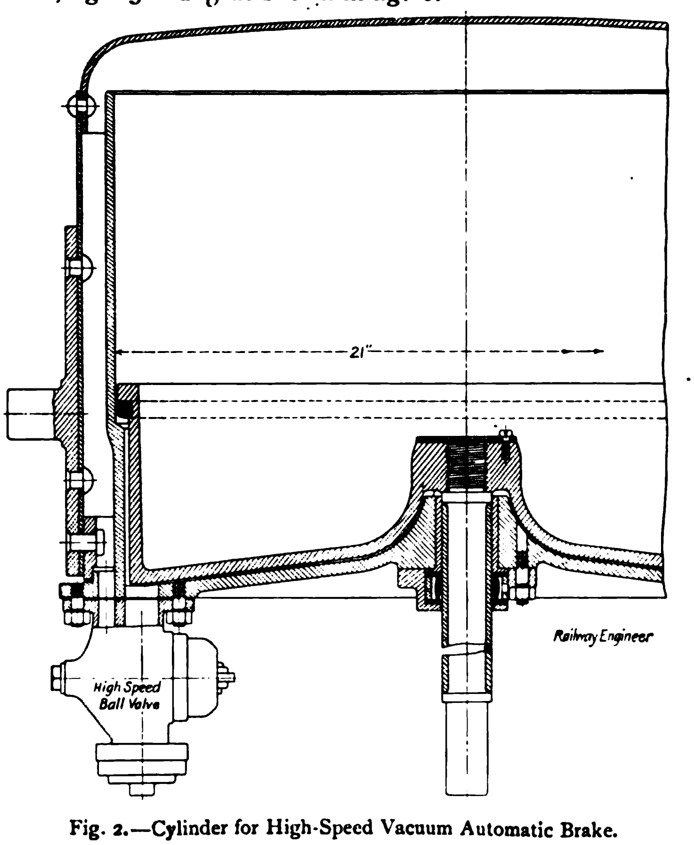


Fig. 2.—Cylinder for High-Speed Vacuum Automatic Brake.

With the High-Speed Brake a vacuum of from 24 to 25 inches is maintained by the use of the improved 40m/m Combination Ejector illustrated by fig. 7, which can, however, be adjusted to work at 20 inches when desired. It is the new standard which the Vacuum Brake Company is introducing

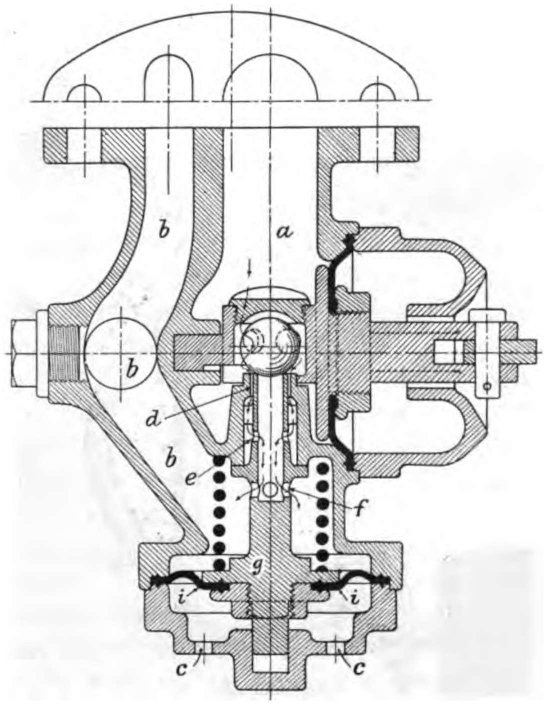


Fig. 3.—High-Speed Ball Valve in Running Position.

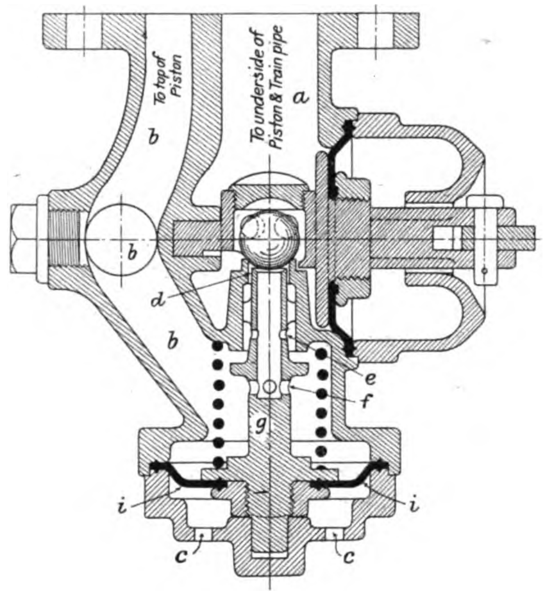


Fig. 4.—High-Speed Ball Valve in "on position."

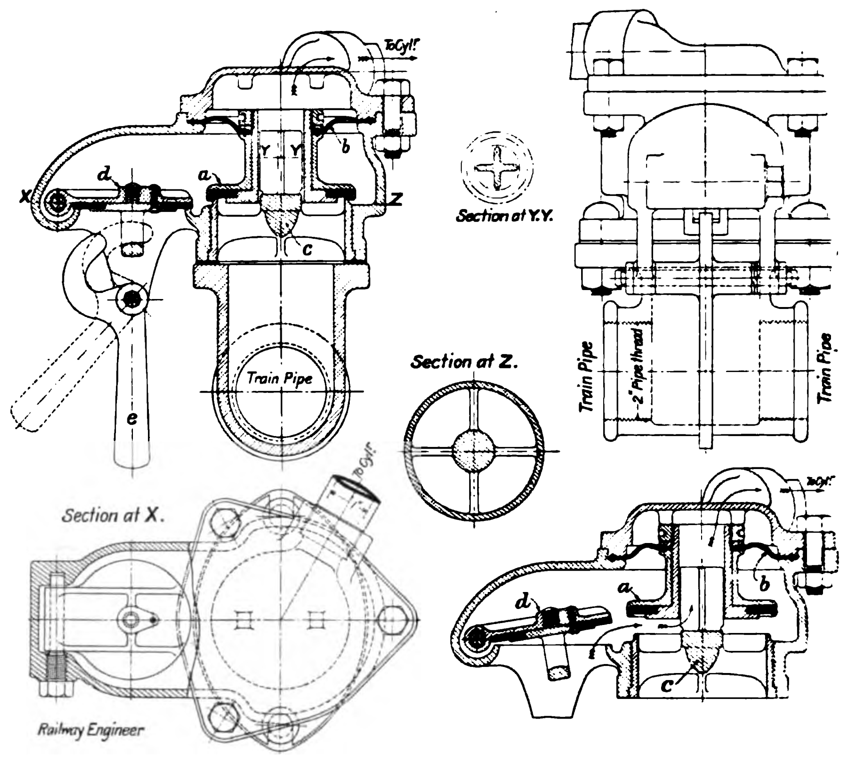


Fig. 5. Rapid Acting Valve. Fig. 6.

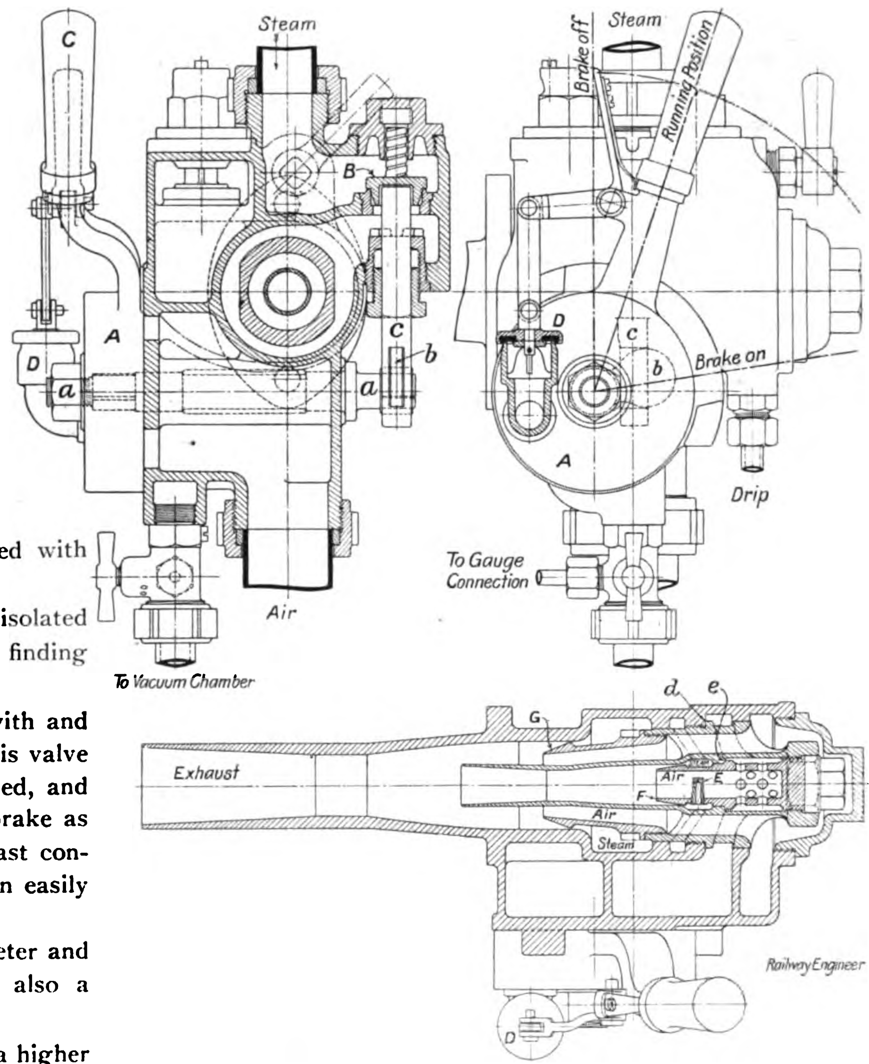


Fig. 7.—Combination Injector for High-Speed Vacuum Automatic Brake.

and it has several points of improvement as compared with the older pattern.

As the steam and air passages in it are absolutely isolated from each other there is no possible chance of water finding its way back into the train pipe.

The large ejector steam disc valve is done away with and a valve *B* of simple construction used in its place; this valve only comes into operation when the large ejector is used, and is not being worked with every application of the brake as was the case with the disc valve; it will therefore last considerably longer, and having a renewable seating can easily be kept in repair at slight cost.

The main air disc valve *A* is much smaller in diameter and works very smoothly without lubrication. It has also a definite step for "running position."

The cones *F* and *G* are modified so as to procure a higher vacuum with less consumption of steam.

The ejector is fitted with an auxiliary application brake *D* for use when making graduated stops with trains fitted either with or without "rapid-acting" valves. The use of this valve also saves wear on the main valve and considerably lengthens the life of the appliance.

The main features of this ejector, which will at once appeal to those who have to deal with combination ejectors, are the isolation of the steam valve and the arrangements for facilitating repairs. It is made in various sizes, right or left-hand and with or without the screw stop valve or steam brake valve. The Vacuum Brake Co. being the original makers of the "Rapid-Acting" and "High-Speed" Automatic Vacuum Brake, their duplicate and spare parts may be relied upon as being the most suitable for the purpose for which they are intended.

Four-cylinder Compound Lignite-burning Express Locomotives in Bohemia; Austrian State Railways.

(*Continued from page 122.*)

In order to be able to obtain a large grate area with a deep fire-box it was necessary to mount the fire-box above the frames, and so avoid any limits to the width save those imposed by the high driving wheels. To do this the frames are cut away (to lower the height of the fire-box), and then reinforced with steel bars 150 *m/m* square riveted on them, thus making an approach towards the bar frame system. The result is satisfactory with the existing system of arranging boilers, although a fire-box of almost any width or any depth can be easily located on ordinary frames when the boiler is simply reversed.

The outer box is 3½ *m.* or 11 ft. 7 in. long. Inside the length is 3·22 *m.* or 3·30 *m.* along the grate, and 3 metres along the crown. The width is 1·070 *m.* At the back the height is 1·32 *m.* and 1·85 *m.* in front. The brick arch is of unusual length, viz., 1·80 *m.* The grate, slightly inclined, is in three panels.

The copper screwed stays of the fire-box are all bored, and open on the outside with the hope that any broken ones may be detected at once; a hole in the fire-box lagging corresponds with each stay in the three upper rows, in which the stays are about 5 *m/m.* stouter than the rest.

The fire-box is provided with numerous washout holes and a big drain-cock is fitted in the throat plate. A couple of 3½ in. Coale safety valves are located over the fire-box in place of the Foster valve, which was, in the first locomotive, placed over the first ring.

The boiler materials are of Siemens-Martin mild steel having an ultimate tensile strength of 33 *klgms.* minimum and 38 *klgms.* maximum per square millimetre with an elongation of 25 % and a minimum sectional contraction of 50%.

The boiler barrel is formed of two rings only, 18 *m/m.* thick, and each one 2·160 *m.* long, giving a total length of 4 metres long between the tube plates. The smallest inside diameter of the largest ring is 1 *m.* 644.

The working steam pressure is 15 Atm., or 220 lbs.

The rings are lap jointed circumferentially and the longitudinal seams butt jointed.

For the Bohemian high pressure boilers and for those of the Austrian State Rs. the cover plates often have the same width on both sides of the joint, the four rows of rivets passing through both plates. This makes a strong joint, but one which is not always to be recommended because the action of the caulking tool on directly-opposite sides of the boiler plate appreciably "seams" the plate.

An exception to this system of strapping the joints is practised at Prague for the boilers of six-coupled engines, "class 180," the outer strap being quadruple and a broader inner strap being sextuple, riveted.

The boiler contains 329 tubes of mild steel, with an outside diameter of 51 *m/m.*; the fire-box ends of the tubes being of copper.

The smoke-box, of slightly extended form and of 1·644 *m.* diam. inside, is formed of 8 *m/m.* plate reinforced to 13 *m/m.* at the bottom. It is not sheathed like the boiler, which has a much great apparent diameter, being 1·812 *m.* outside its plates of 1¼ *m/m.* metal.

The boiler centre line is 9 ft. 3½ in. (2·830 *m.*), and the top of the chimney 4·570 *m.* or 15 ft. from rail level, for the loading-gauge of Austro-Hungarian Rs. is the largest in Europe, excepting that of Russia, and it will allow for very considerable future enlargements of the locomotives.

In Austria the proportions of the chimneys are very carefully studied with the object of obtaining the maximum effect of the blast, the straight piece of pipe on American engines, and which would work either way, vertically or out of centre with the blast pipe, does not find favour in Central Europe.

The inside diameters of the chimney, in this case, vary from 426 *m/m.* to 480 *m/m.* in a height of 910 *m/m.* It has a petticoat extension inside the smoke-box, 635 *m/m.* wide at its lowest part and slightly cut away on the side towards the tubes.

The "front-end" is fitted with a spark arrester and the blast nozzles reach a little beyond this netting, or above the line of the top row of tubes. The smoke-box is closed by the double-folding flat doors commonly employed in Austro-Hungary, and which when opened uncover the tubes only to the level of the top row, and as one half can be opened at a time a minimum area of tube plate is exposed whenever it is necessary to open the front while the engine is in steam, whereas the round door exposes the whole of the tube plate from top to bottom.

The cab has a height of 2·880 *m.* and a width of 2·736 *m.* over all, yet these ample dimensions appear small with the large fire-box end. Boards 150 *m/m.* high on either side bring up the foot-level to the foundation-ring, and steps are fixed to the boiler-head for reaching the top of the boiler or for trimming the cab-lamp.

The sides of the cab are curved around at the back of the foot-plate and the waist-rail serves as half-standing seat for the driver.

The cab is constructed of the thinnest plate (2½ *m/m.* for the cab roof) in order to reduce weight; and the stanchions are hollow. The driver's operating handles and levers are grouped with especial care to save space.

The bracket for the screw reversing gear bolted to the right-hand side of the fire-box is scaled up to 80 % of the cut-off in forward gear. Close to it on the left is a pivoted loop handle acting directly on the ouside rod of the regulator. This rod, it will be seen, connects to an arm working a shaft which passes through a stuffing box in the boiler barrel. The opposite end of

the shaft is carried in a bearing riveted inside the boiler and an arm in its midlength connects by link with a flat valve covering a V-port in the steam pipe.

There are no fittings which distinguish this engine from an ordinary two-cylinder single-expansion locomotive.

In order to work the engine as a four-cylinder single expansion engine the reversing gear is set fully forward and the return to compound working is effected automatically by reducing the cut-off to about 70%. This device, which consists mainly of live steam holes in the valve face, constitutes the Gölsdorf system.

Just by the side of the reversing screw is a row of loop pull-handles arranged on a frame, for the variable blast nozzles, for the cylinder cocks and for the Holt-Gresham (type R) sander.

The sand box is concealed below the running board and the vertical spindle for operating the steam sander valve is visible in the photograph.

The handles and gauges for the "rapid acting" automatic vacuum brake are located a little above, but in close proximity.

Below the reversing screw, with its dial turned upwards at an angle, is the Hausshälter tachometer and speed recorder.

The boiler is fed with two Friedmann Class S.T. No. 9 injectors, and it supplies an apparatus for steam train-heating in winter time.

The cab ventilator is worth noting. It consists of a box with an inclined and pivoted vane therein, which can be adjusted more or less closely to the orifice at the back, so producing a keen or diffused draft according as may be desired. As the back end of the cab roof is closed in by a plate 300 *m/m.* deep the warm air collecting therein can be rapidly evacuated when the engine is running, by means of the ventilator.

Provision is made for the relief of excess steam pressure and for air suction in the cylinders by combined valves, placed one in the front of each receiver. The lubrication of the cylinders and valves is effected by a Friedmann oil force pump.

The buffer brackets are of the open Continental pattern. Their manufacture is very simple. A flat forging in the shape of a cross with a hole in the middle is placed in a press and then comes out of the die duly flanged and bent to the conical form required for the volute buffer-spring.

The tenders still used with these engines are improved six-wheelers, with side-filling water-traps close to the footplate, so that the fireman is able to manœuvre the water crane from the foot-plate.

But there are other eight-wheeled bogie tenders of a novel form, with lozenge-section water tanks, having a capacity of 21 cubic metres (21 tons, or 4,700 galls.), and surmounted at the front end by rectangular coal bunkers. These tenders, built by a well known firm at Prague, are, however, too long to be turned simultaneously with the new locomotives on the existing 16 metre turntables at Nuslé, and will not be regularly employed until the new 18-metre turn-tables have been provided at the terminals. There are no gates between the engine and tender, and even the chain guard, obligatory in France and Italy, is not employed.

The thorough cleaning of these four cylinder engines requires about 15 hours, and is generally performed only twice a week, according as the service of the engines permits.

The Bohemian brown coal which is loaded on to the tenders of the engines at the Nuslé depôt, near Prague, is of various qualities; the best, a good lignite, costs at the pit's mouth 5½ kronen per ton, but another costs only 2 kronen 70 hellers per ton (say 27d.).

This latter poorly-fossilized wood is that which is supplied to the new engines and which would be unfit for the other express locomotives without admixture with a black coal. This mixing is often an advantage to the ordinary coal for it serves to prevent the strong clinkering tendencies of the "Ostzau Buschtechraider" mineral which costs 13 kronen per ton at the pit; and 1 *klgm.* of a mixture of half good black and good brown coals generates on an average, and with a clean grate, 5 *klgms.* of steam.

Engines burning black coal have a red band painted around the base of the chimney, and drivers of such are fined if the engines are detected smoking in stations. The use of poor brown coal has already effected a saving of 600 kronen per day at the 150 engine depôt of Nuslé.

The calorific value of this lignite may be roughly estimated at 3,000 calorics per *klgm.*, and its evaporative value 3 *klgms.* of steam.

From this it is apparent that use of an inferior fuel may often be a means of effecting desirable economies when locomotives can be built to use it with good efficiency.

The principal desideratum is an abnormally large boiler which represents a great storage of potential energy in the form of hot water. The importance of this is striking with the Bohemian locomotives, for sometimes while on the road the fire-door is thrown open and the grate is seen covered with the burnt out embers of a thin fire and so dead black that it is not possible to see beneath the brick arch. At such moments the steam pressure will have fallen from 15 *klgms.* to 11 *klgms.*, and the load behind the tender will be 280 tons. How the fireman succeeds in re-making his fire completely, and the locomotive maintaining steam in the interval until it is once more incandescent, seems to have only one explanation, and that is the large grate area and the great capacity of the boiler.

The work of firing on these large engines does not appear to be particularly exhausting since the coals are assisted forward by the inclination of the grate, but the filling of the corners of the box apparently requires more effort. Nevertheless towards the end of a run the fireman (like all Central Europe firemen) loses energy and then lights up a long pipe having a heavy china bowl, and this swings rythmically like a pendulum in the mouth between the filling and unloading of his shovel. The coal is very light, but it burns quickly and it generally requires about twelve rounds from the shovel every three minutes to maintain the fire.

The door is opened by means of a wooden handle fixed to the hinge pin and the fireman is generally aided in this by the driver. who opens the door for his companion.

The light brown smoke occasionally emitted is insignificant, and yet the cleanliness with such coal is less than with the older black coal burning locomotives of the Vienna-Gmünd division, and which are fully equal to English engines as regards cleanliness. The interior of the cab, and also the boiler end, are painted a buff colour, which, however, shows up the brown dust arising from the coal. The hose for spraying the coal on the tender and footplate during the hot weather is provided on these engines, but the fireman prefers to wash the floor by means of a small bucket of water.

These engines are specially designed for free steaming at high speeds with a minimum of back pressure in the various passages. As already said the ratio of the cylinder expansions is 1 to 3, and the receiver capacity is very large, viz., four times the volume of one high pressure cylinder, while the clearance volumes allowed in per cent. of the volume swept through the cylinders at each stroke are 14 for the high pressure and 10 for the low pressure. The drivers generally find it best to work the engines with a late cut-off and to throttle with the regulator, the result being less back pressure in the exhaust ports and a saving of water.

The water evaporated in the Gmünd to Praja direction —200 *kiloms.*, with 70 *kiloms.* of gradient at 10 and 11 per thousand, with a load of 250 tons, and speed on the inclines of 40 miles per hour—is 20 to 21 cubic metres.

In starting a train the admission given to the cylinders is 85% for a second or two; and then to 50 or 60% when on the up grade, and to 40% and 45% on the level, the regulator being opened ¾ to ½ or ⅜ on a slightly falling gradient.

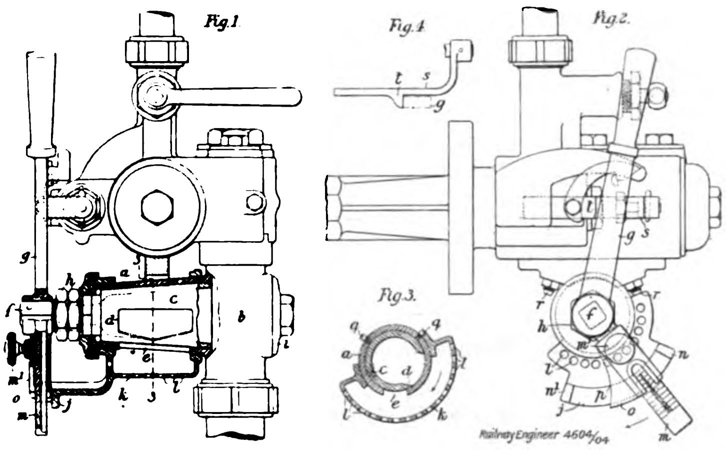
The loads hauled are never particularly heavy on this line, and the speed is more usually 56 miles per hour than less; and if 57 miles per hour is reached the speed is at once controlled by brake. But with the numerous inclines of 1 in 100, and a ceaseless series of sharp, simple and reverse curves, slackenings for these and for stations, this single line is not at all suited for fast running; and the engine is no easier in its riding over such a track than is usually the case with other "Atlantic" type locomotives.

None the less the speed of 56 miles per hour is frequently noted, whilst the grate is covered with nothing but burnt-out chips of coal, and the pressure has sunk to 13 *klgms.*, and is still continuing to fall to 12½ *klgms.*, and yet lower the next time that the fire door is opened upon a bed of still unlighted fuel, while the water in the gauge glass has dropped to the bottom of the tube, just when a subsequent station stop enables the fire to pick up again and the steam pressure to return to 14 and 14½ *klgms.*, even while the engine is starting on its next trip; and the water is, once more, renewed until it reaches the top of the glass in order to keep the valves from blowing off. To anyone used only to black coal in small boilers the manner in which these engines steam when the fire is apparently dead out, and the way the fire lights up again, is really surprising and worth going so far to see.

Recent Patents relating to Railways.

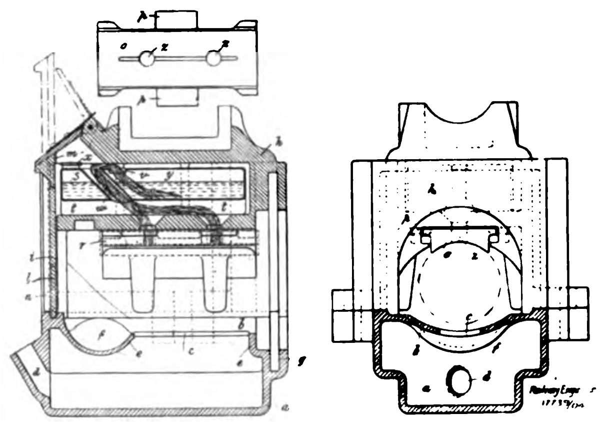
THESE abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d*. each.

Brakes (Automatic). *4,604. 24th February, 1904. The Consolidated Engineering Co., Ltd., and H. E. Brown, Gotha Iron Works, Slough, Bucks.*
This invention relates to a driver's brake valve in which the opening is effected in two distinct stages, the first stage being one in which the opening is limited in a degree capable of variation and adjustment, and the second effecting the full opening of the valve. In carrying out the invention a cock *a* is provided with a graduated arm *m* which moves over a sector *j*, and is fitted with a sliding stop piece *o* having an inclined or curved surface *p* which is adapted to be brought in contact with n^1 when the valve is opened. The sliding stop *o* is adjusted upon the arm *m* to a position corresponding to the number of vehicles composing the train, and owing to the inclination of its surface its position controls the extent to which the cock or valve can be opened for the first stage. The sector *j* is frictionally mounted upon the cock *a* and, when it is required to make an emergency stop, the valve handle has extra pressure applied to it sufficient to cause the sector to be itself moved, thus enabling the cock or valve to be fully opened. Or, in lieu of the adjustable stop upon the cock or valve arm, the stop



may be adjustable upon the sector. (*Accepted 2nd February, 1905.*)

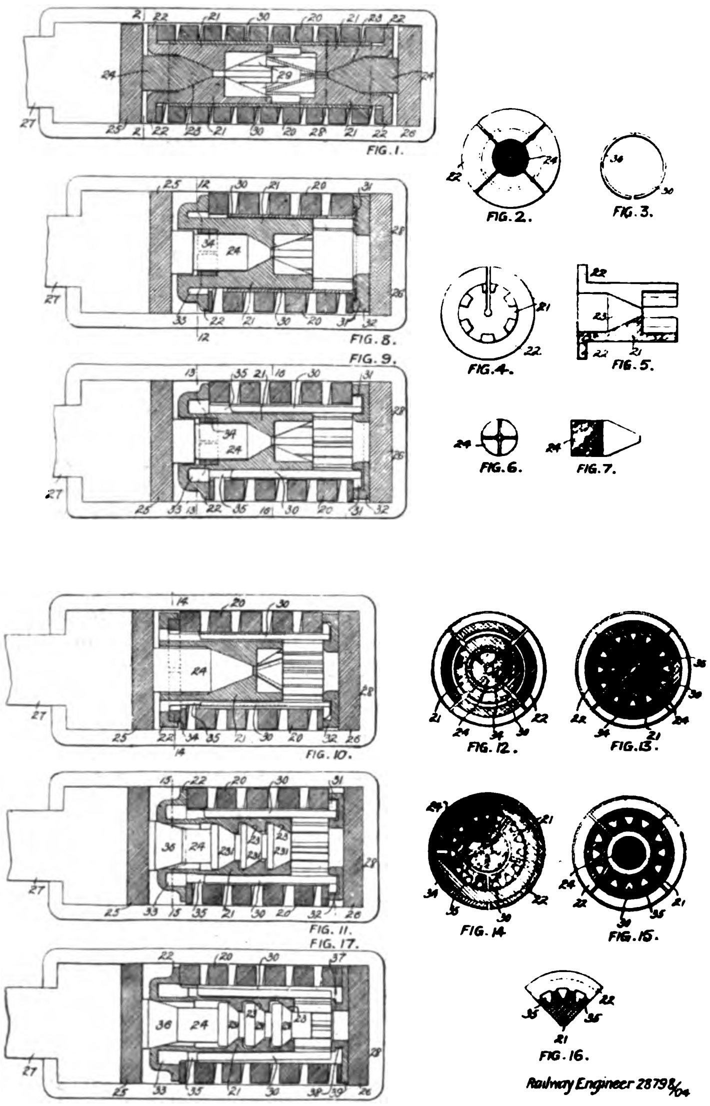
Axle Boxes (Wagon). *17,739. 16th August, 1904. A. J. Smith, 18. Plasnewydd Place; T. Thomas, 18, Pitman Street; and F. S. Richards, 28, Talworth Street, all of Cardiff.*
The axle-box, which is adapted to contain oil, is made as usual in two sections that are bolted together. Instead of having a packed joint between these two sections the lower box *a* is cast in one, with a dish-shaped top *b* having a central hole *c* for the passage of the horse-hair pad. The dish-shaped top prevents the oil from running out of the lower section when the wagon is tipped, and it also retains any grease, if such be used, that runs through from the top box, and holes may be provided on the sides of the box to allow of its escape. The top box is of the usual con-



struction, except that its front side is a sliding plate that is inserted from the bottom, so that it cannot be removed when the top box is placed on the bottom, but it has a limited slide to enable the brass to be exposed. The brass is slid into place from the open side, and can easily be removed on opening the slide and relieving it of the weight. This slide also retains in place the oil tank, which is also inserted through the open side, but it cannot when in place be opened sufficiently to allow the oil tank to be removed. The oil tank is provided on its under surface with a channel to receive the usual distributing wick, and the syphon wick passes up out of the top of the oil tank and down through an

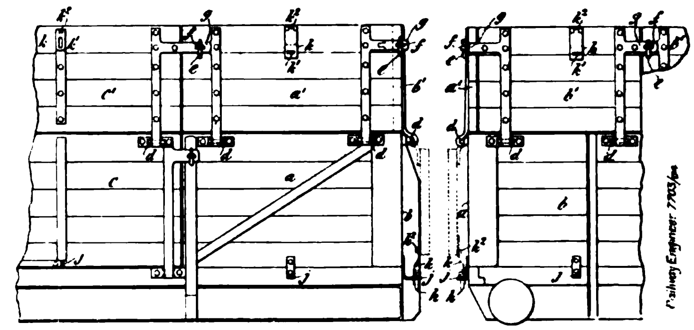
inclined hole through the tank to the distributing wick. The oil tank is filled through a screw-cap that is exposed by opening the usual cover on the front of the top box. (*Accepted 23rd February, 1905.*)

Buffers and Draw Gear. *28,798. 29th December, 1904. (Date claimed under International Convention, 8th January, 1904.) G. Westinghouse, Westinghouse Building, Pittsburg, Pennsylvania, U.S.A.*
This invention has reference to spring and friction devices for draw gear and buffing apparatus, and provides a combined spring and frictional arrangement in which the main resistance spring itself acts as a casing for holding the enclosed friction parts against transverse movement. A helical resistance spring 20, preferably of rectangular cross section, is provided, and within



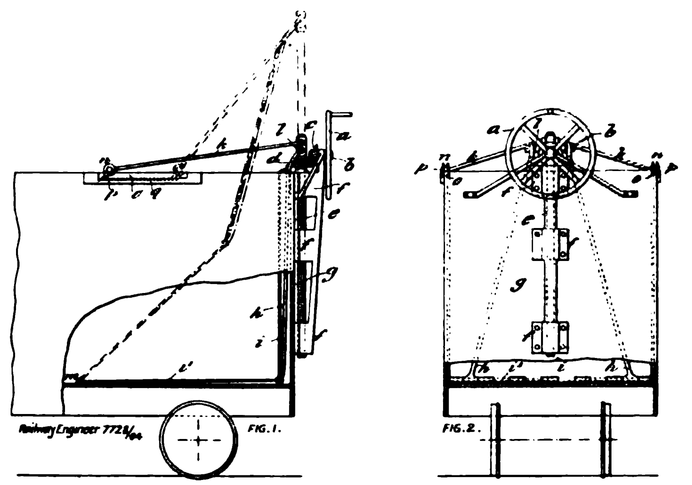
the cylindrical space at each end of the coil of the spring are located friction segments 21, having flanges 22, extending outwardly over the ends of the coil, and inclined or conical surfaces 23 engaging a corresponding inclined surface of the central wedge blocks 24, the whole device being located between the followers 25 and 26 of the draw bar 27 and strap 28. The inner adjacent ends of the two sets of segments are notched, as indicated at 29, and are alternately spaced so as to overlap each other and allow for longitudinal movement of the segments as the spring is compressed when the apparatus is subjected to draft or buffing strains. Between the outer faces of the segments and the inner cylindrical surface of the helical spring is located the split sleeve 30. (*Accepted 2nd February, 1905.*)

Wagons. *7,703. 31st March, 1904. W. T. Durrant, The Orwell Works, Ipswich, and F. Saward, Brantfell, Tuddenham Road, Ipswich.*
This invention provides folding extensions, or flaps, for raising the sides and ends of wagons when light and bulky goods are



being carried. The flaps, a^1, b^1, c^1, are hinged to the tops of the sides and ends of the wagon so that they can be folded down out of the way when not in use or raised when required. They are secured in the raised position by fastenings *e*, *f*. (*Accepted 2nd February, 1905.*)

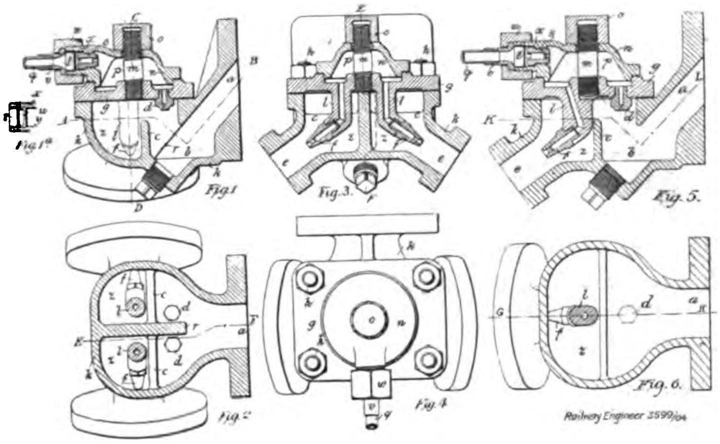
Hopper Gear for Wagons. *7,728. 31st March, 1904. G. E. Holland, Captain R.N., Kensington Palace Mansions, London.*
This invention provides a detachable hopper gear by means of which square-ended vehicles can be converted at will into hopper vehicles. For this purpose a false end and part false bottom hinged together with their angle towards the end of the wagon are provided at each end of the vehicle, the inner end of the part



false bottom being pivoted transversely of the wagon, so that when the upper end of the false end is raised vertically the bottom and end together form a sloping end. A suitable elevating gear is employed to raise the parts, and stayed by self-adjusting rods *k*, provided with pawls engaging with racks *q*. (*Accepted 2nd February, 1905.*)

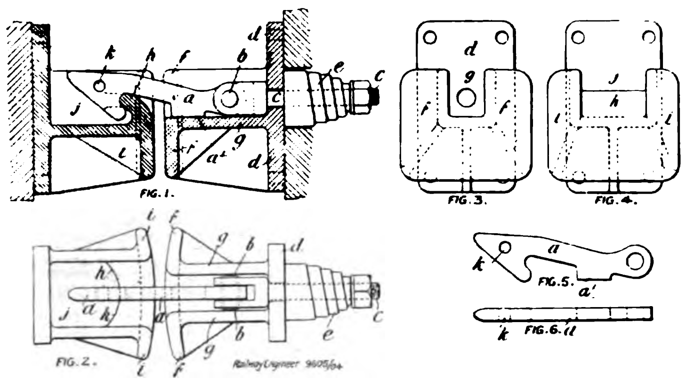
Sand Trap. *3,599. 12th February, 1904. H. E. Gresham and F. J. Gresham, Craven Iron Works, Salford, Lancaster.*
Relates to sand traps for locomotives or tramway vehicles, from which the sand is discharged by compressed air. The trap comprises a sand holding chamber *b*, fed by a passage *a*, and separated by a lip *c* from two sand delivery chambers *z*, which are separated one from the other by a partition *r*, which extends into the chamber *b*. An air chamber *p* is formed above the chambers *z* by a plate or cover *g* and cap *n*, the cap being adapted to have its angular position altered at will, and the admission of air to the chamber being by way of a passage through the cap. Compressed air enters by a pipe *q* and passes through a grid *t* which helps to

keep back foreign matter in the air. The air then passes through a nozzle *s*, or orifice *y* in the plate *u* and expands into the chamber *p*. From this chamber it passes through nozzles *d* and plays on to the surface of the sand in the chamber *b* so as to lift the sand over the lips *c* into the chambers *z*. From these chambers the



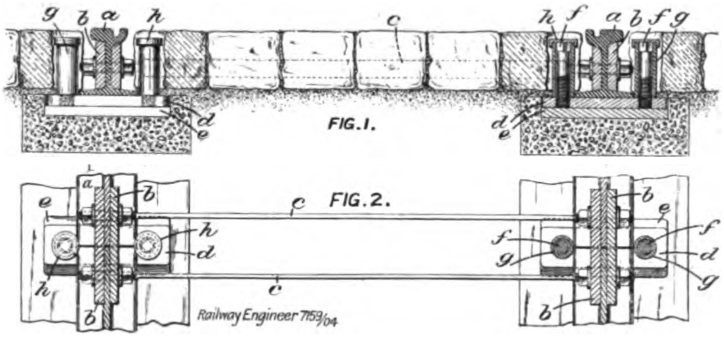
sand is discharged partly by the action of gravity but mainly by the action of the air passing through nozzles *f*. By employing the partition *r*, one side of the trap is independent of the other; and one pair of nozzles can if desired be worked without the other pair, that is, one nozzle such as *f* and one nozzle such as *d* can work together without the other nozzles. By removing the cover *g* access can be readily had to the interior of the trap. (*Accepted 9th February, 1905.*)

Combined Buffer and Coupling. *9,605. 27th April, 1904. A. Paterson, 9, Glossop Terrace, Cardiff.*
This coupling is applicable to wagons for railways in and about yards, also to tubs in mines. It is combined with a central buffer, a coupling hook being mounted in one buffer and adapted to engage automatically with an inturned lip formed on the opposing buffer. The coupling hook is pivotally connected



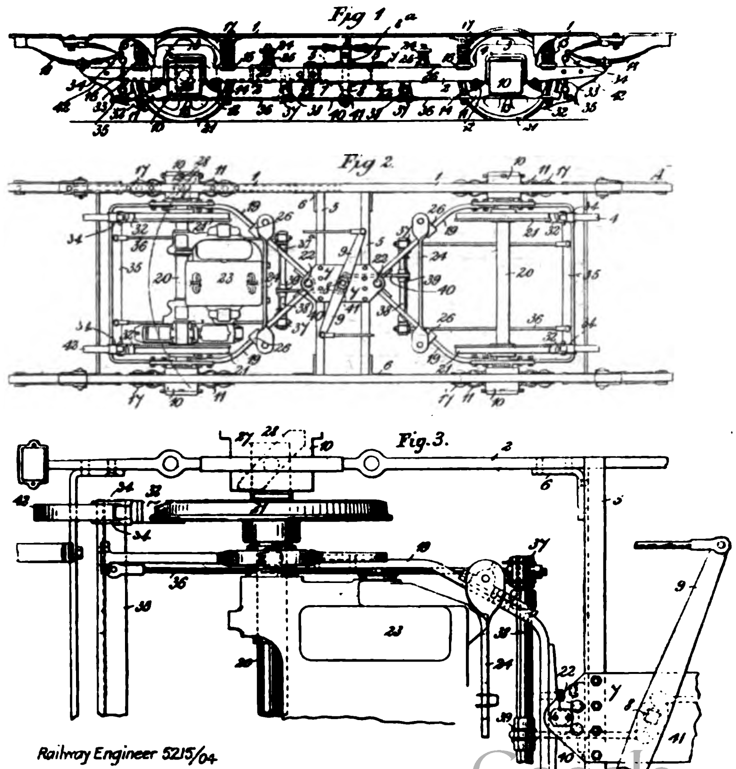
towards its inner end with a drawbar which is fitted behind the back plate of the buffer with a helical spring. The buffer face plate and shank are channelled to take the coupling hook and part of the drawbar, which latter is extended into the buffer from behind. The face plate and shank of the opposing buffer are also channelled to enable the coupling hook to pass into engagement with the lip. The lip is so curved that the coupling hook is always directed to the centre—that is to say, to the line of traction, after any departure from it in coupling on curves or in travelling around curves of the railway track. (*Accepted 23rd February, 1905.*)

Rail Supports. *7,159. 25th March, 1904. R. C. Bullough, 55, Piccadilly, Manchester.*
The rails are supported by screws *f* which screw into a sole plate *d* and pass through the plate *d* so as to abut or rest upon a foundation plate *e*. The upper ends of the screws *f* are shaped so that they may be engaged and rotated by a suitable key from above the road, the road itself being sufficiently cut away to permit access. As shown the rails *a* and the plates *d* are resting solidly upon one another and upon the foundation plate *e*, but it is evident that if it is desired to raise a rail from any cause this may



easily be done by rotating the screws or any one of them and causing them to pass through or project from the lower side of the plate *d* and press against the foundation plate with the result of raising the plate *d* and the rails resting upon it and separating it from the foundation plate *e*. Casings or caps *g* protect the screws from dust and dirt. (*Accepted 2nd February, 1905.*)

Trucks and Brakes for Tramway Vehicles. *5,215. 2nd March, 1904. E. E. Cook, Falcon Works, Loughborough, Leicester.*
This invention relates to a four-wheel truck provided with a relatively long wheel base, and with each pair of wheels mounted in a pivoted frame which also carries the brake gear for the wheels. Each frame 19 is pivoted at its inner end to the truck at a point between the axle and the centre of the truck, and partially supports an electric motor. The axles are able to radiate when the car is entering or leaving a curve or turnout, for which purpose they are mounted in compound journal boxes of known construction. The brake work is supported from the outer end of each frame 19, the brake blocks 32 being carried by links 33 that are attached to arms 34 on the frame 19. The brake blocks 32 of each pair of wheels are also connected together by means of a transverse bar 35, that is connected by two links 36 to two depending arms 37 of a rotatable transverse shaft 38 mounted



in bearings in downwardly extending arms 37[a] at the inner part of the frame 19. This transverse shaft 38 has a third depending arm 39 that is connected by a link 40 to one arm of a short two-armed lever 41, carried by and connected to the lower end of the shaft 8. The arrangement is such that when the shaft 8 is turned by operation of the brake handle, motion is communicated to the transverse shaft 38 which is partly turned on its axis in such wise that the links 36 are caused to pull on the transverse bar 35 and so bring the blocks 32 into contact with the wheels. The brake blocks 32 are normally held in the "off" position by means of springs 42 that are connected to the transverse bar 35. *(Accepted 2nd February, 1905.)*

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A.D. 1904.

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A.D. 1905.

135. Apparatus for placing detonators in position or removing them; Zahl. 194. Weighing machines for rolling stock; A. Spies, G.M.B.H.

Electrically Operated Carriages; Metropolitan Railway.

(Continued from p. 113.)

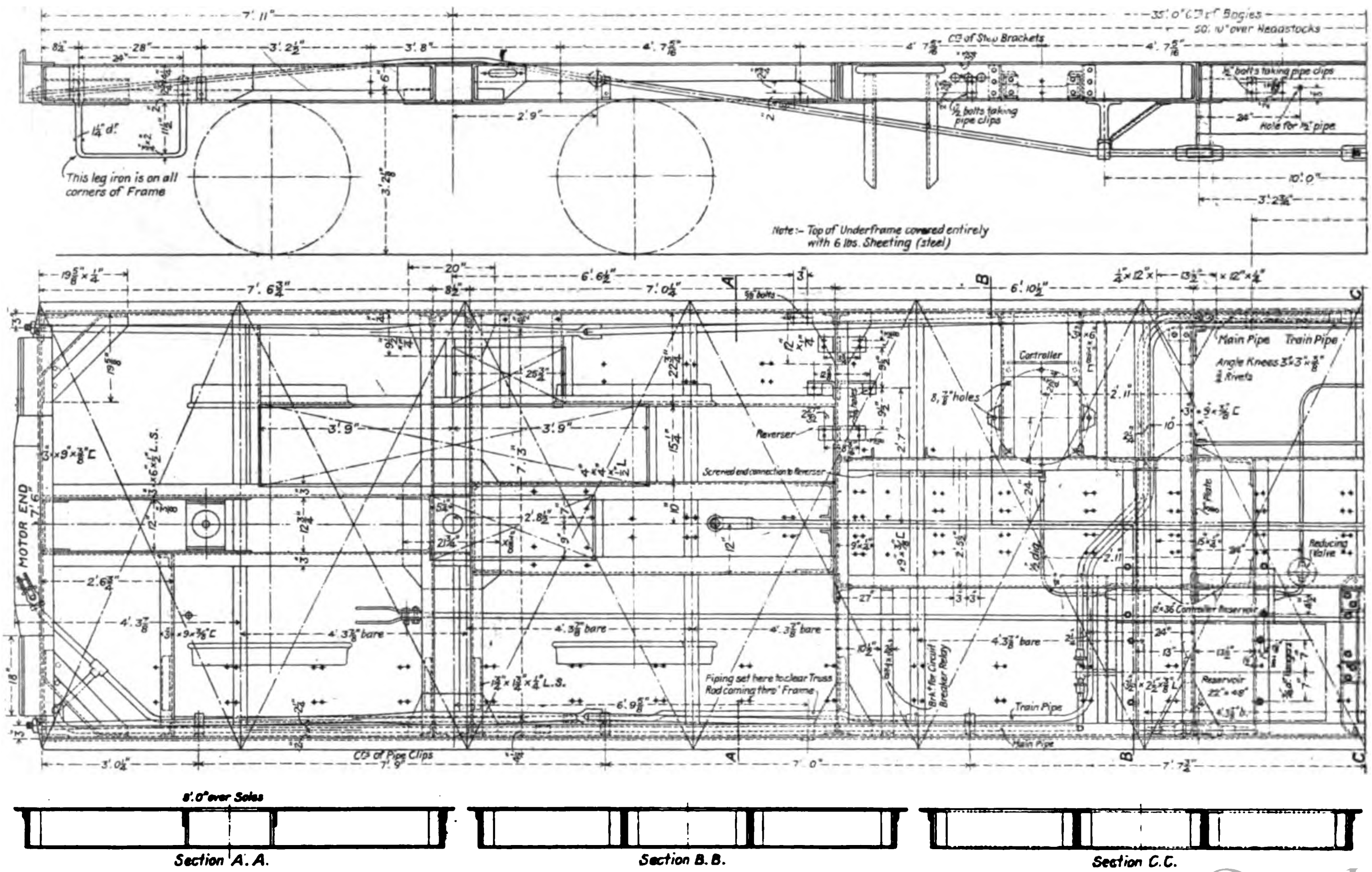
In our last issue we published complete drawings of the bodies of the new carriages which have been built in connection with the electrification of the Metropolitan R., and we now publish the drawings of the underframes, showing the general arrangement of the Westinghouse "quick-acting" brake.

All the underframes are constructed of steel channels and angles which have a tensile strength of from 26 to 31 tons per sq. inch, with an elongation of 20% in a length of 8ins., and which are capable of being bent double, when cold, round a bar, the diameter of which is not more than twice the thickness of the test piece, without showing any sign of fracture.

The rivets are of steel, having a tensile strength of from 25 to 28 tons per sq. inch, with an elongation of 25% in 8ins., and which will bend double on itself, when cold, without fracture.

The buffer is a very neat arrangement, consisting of a steel plate bent to a U shape, one leg of which slides under the floor plate, and the other on a plate attached to the headstock. The buffer plate is pressed outwards at each end by springs as shown on the drawings.

The drawings are fully dimensioned, and we do not think it



Electrically Operated Carriages, Metropolitan

is necessary to give a longer description now as we shall in our next issue publish the drawings of the bogies for the motor and trailer carriages, together with some further particulars of the brake arrangement.

It will be noticed that the floor plates entirely cover the underframe and efficiently brace all the members together.

We are indebted to Mr. A. Ingram, carriage and wagon superintendent of the Metropolitan R., for the drawings from which our illustrations have been prepared, and under whose supervision all these carriages were constructed at the works of the Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd., of Saltley, Birmingham.

(*To be continued.*)

Railways and the Board of Trade.—IV.*

(*Continued from page 79.*)

In sending the report to the Company the Assistant Secretary of the Board of Trade will inform the Secretary of the Company that they sanction the opening of the new work, adding, if there be any requirements, subject to the carrying out of the requirements noted. If there be any the Company will advise the Board of Trade when they are complied with, and this advice is sent on to the inspecting officer, who will, if the requirements were numerous or important, suggest that a re-inspection be made.

The foregoing list of requirements is dated August, 1892, and when a new edition is issued it will probably contain few fresh instructions.

* Nos. I., II., and III., appeared in the *Railway Engineer* for January, February, and March, respectively.

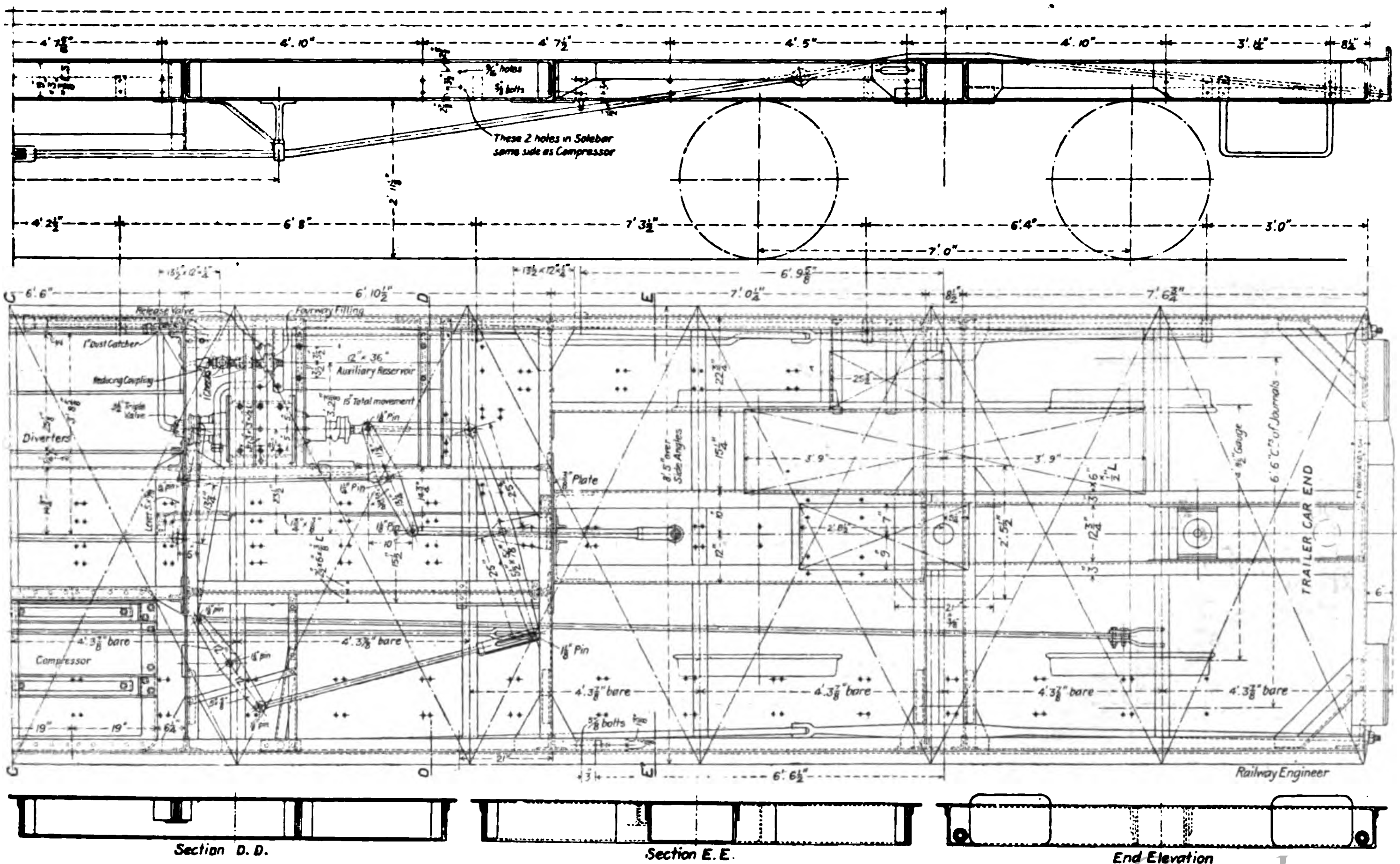
Some of the existing regulations might with safety be omitted, as they are somewhat prehistoric, whilst others might be clearer.

For instance, there are no instructions given as to what plans, etc., are to be sent in when an alteration is made to an existing railway. If such instructions were included in a future edition it would be as well to specify how much of the permanent way has to be shown. The Board of Trade's wishes are that sufficient shall be shown so that all the signals (except the distant signals) worked from the signal-boxes affected can be shown on the plan, to scale.

Instructions might also be incorporated as to the preparation of signal diagrams.

Requirement 5, as to facing points, will probably be amended. The distance allowed has been increased from 180 yards, as it was in 1892, to 200 yards, and now a greater distance is asked for, and this request may lead to a requirement as to the maximum distance point-rod rollers shall be apart, and something might be said about detectors. It should also be said that the 300 yards limit for trailing points applies to the safety points on goods and mineral lines at the junctions of those lines with passenger lines. Some years ago there was a question with the Board of Trade as to whether facing safety points, run over by trains at a high speed, should not be included in the 200 yards restriction. Perhaps something may be said about this.

The words "brought close together" in requirement 6 might be omitted. Present day readers would imagine that the levers working points and the levers working the signals applicable to such points should be together. Whereas the



Railway. Motor Car Underframe.

phrase has reference to the time when levers were scattered about a yard and not concentrated.

The word "cabin" should also be altered to "signal-box," as that is the title officially adopted by railway companies in their rules and regulations.

Requirement 9 would be clearer if worded "When a junction is situated near to a passenger station, the platforms to be arranged as far as possible, so that trains standing at them shall be clear of the junction."

Requirement 12, as to the width of platforms (6 ft. for small traffic and 12 ft. for important stations), should provide a minimum width for island platforms.

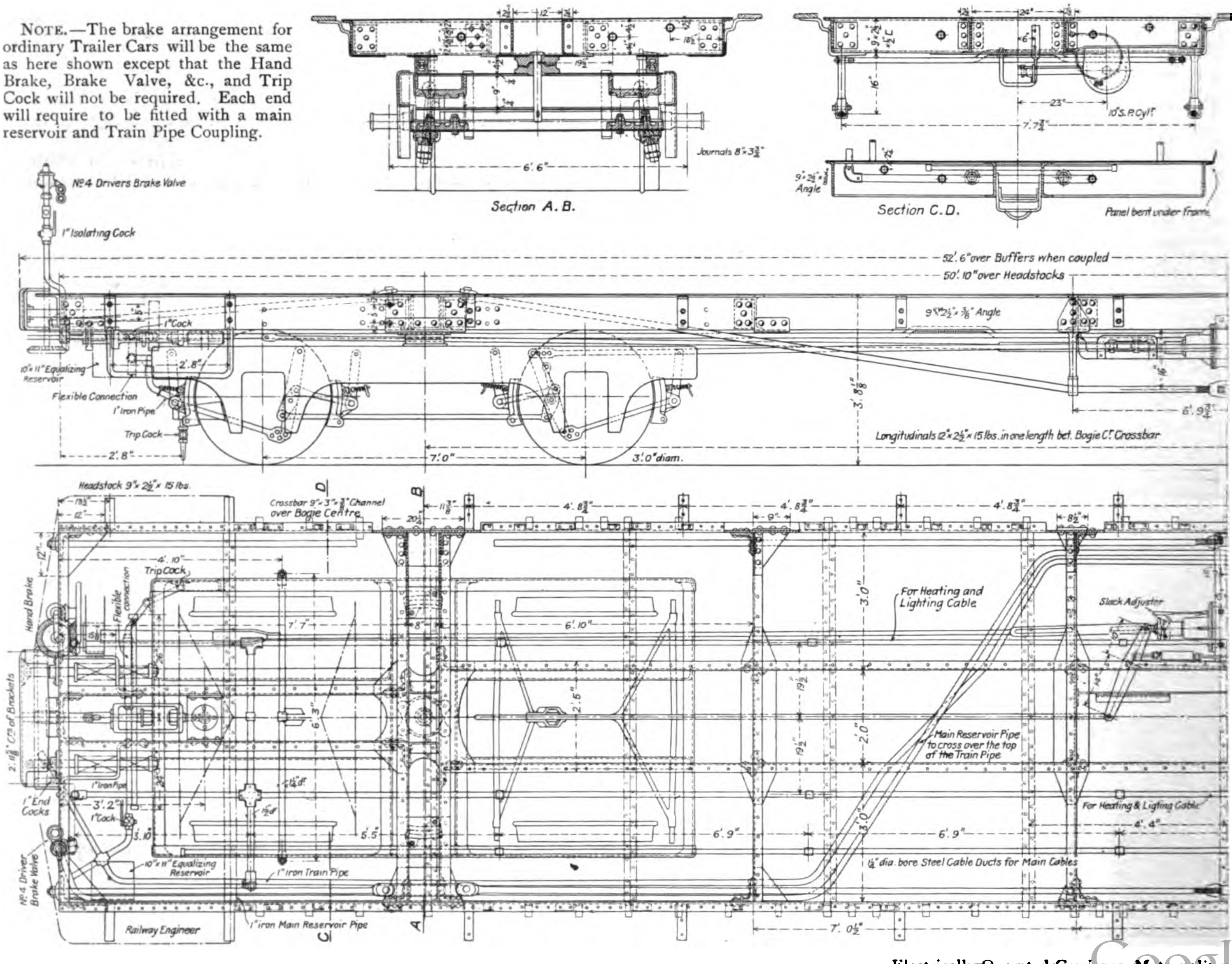
As runaway catch-points are sometimes required at other places than at "stations or siding junctions," *e.g.*, junctions with other lines, intermediate signal-boxes with or without cross-over roads, etc., requirement 16 should be made wider in its application, and it is suggested that the terms should be where "the gradient at any home signal is necessarily steeper."

The wording of the requirements (No 29) as to level crossings needs large amendment. As now worded it expresses a preference for single gates as against double. But as the Board of Trade must favour gates that are worked simultaneously from a signal-box, they must naturally prefer double gates—four in all—as these are opened altogether, whereas two single gates have to be opened one after the other, or they overlap. Again, red discs are not necessary where signals are provided, and the requirement when amended will no doubt specify for home and distant signals in both directions instead of "semaphore signals in one or both directions." Reference will probably be made to the desirability of working gates simultaneously from the box, and the omission to mention the control of wicket gates should be remedied.

In the recommendations no doubt the suggestion as to raised roof for the brake-vehicle will be omitted. The observation as to extended sides may possibly remain, although some companies do not provide side look-outs for some of their stock. But the height and width to which modern carriages are built has reduced these look-outs to a minimum.

Future issues of Board of Trade requirements may possibly contain some orders as to power-worked and automatic signals, but possibly their use is not yet sufficiently extensive to allow for standard requirements to be tabulated.

NOTE.—The brake arrangement for ordinary Trailer Cars will be the same as here shown except that the Hand Brake, Brake Valve, &c., and Trip Cock will not be required. Each end will require to be fitted with a main reservoir and Train Pipe Coupling.



Electrically Operated Carriages, Metropolitan

Something ought, however, to be done as to Light Railways and electrically worked lines.

The only regulations issued as to electrically operated roads have reference to the precautions to be taken against the risk of accident by fire on underground electric railways.

Board of Trade Requirements as to Electrically Worked Railways.

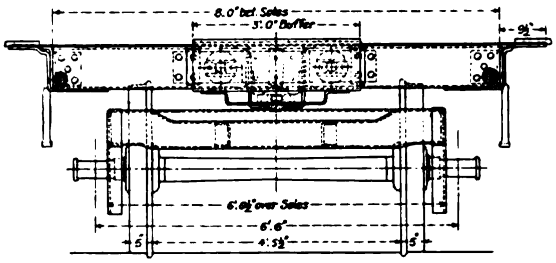
These were issued in May, 1904, and are as follows :—

Stations and Permanent Way.

1. Sleepers to be of hard wood, not creosoted, and to be laid in concrete or ballast and covered with a layer of gravel or finely broken stone free from dust, the ballast to be finished to a level surface so as to form a convenient roadway for passengers in case of emergency. If ballast is not used, the space between the rails to be covered with granolithic slabs, or slabs of a similar material, to form as wide a roadway as possible for passengers. No timber planks to be used.

2. Tunnels to be provided with lights capable of being turned on from the stations at either end of the section, and, if necessary, at some intermediate points. The lighting circuits to be independent of the traction supply.

3. Separate entrances to, and exits from, each platform of the stations to be provided and to be situated as nearly as possible in the middle of the platforms.



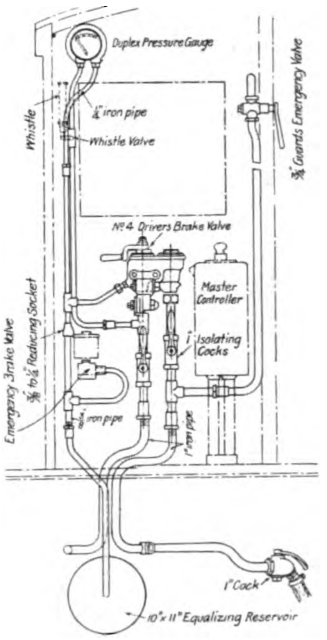
End Elevation.

4. All stairways, passages and exits from the stations to be conspicuously lighted. Not less than 25 per cent. of the lights in these places to be supplied from independent source. If necessary, the exits to be made more conspicuous by the use of coloured lights in addition to white lights.

5. Platforms are not to be made of wood, and woodwork to be eliminated as far as possible from signal-boxes, lifts, offices, etc., below ground.

6. Efficient hydrants, hose and fire prevention appliances to be provided.

7. Ventilating ways to be provided, wherever possible, from the stations and tunnels to the surface.



End View showing Brake Valve and Connection in the Motorman's Compartment.

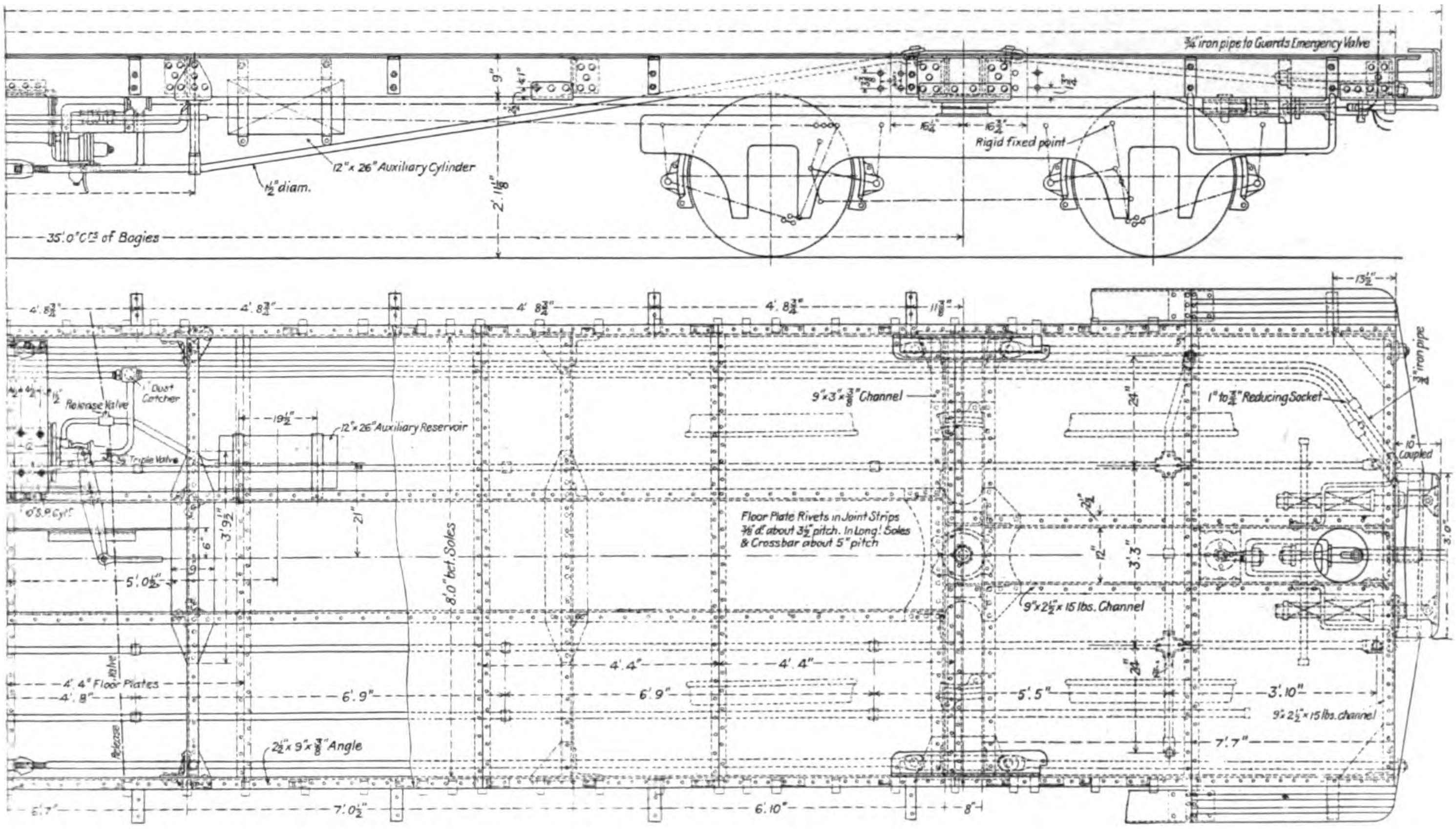
Equipment.

8. Cars to be constructed of metal; woodwork to be reduced to a minimum and to be non-inflammable. Hard wood to be used in preference to soft. Interior fittings, panels, seats, etc., to be of incombustible material.

9. No main electric cable to be carried through the train, and motors to be placed on the front and rear carriages only. No motor to be situated in the middle of the train.

10. Means to be provided at both ends of every train to enable passengers to alight from the cars in case of emergency. Oil lamps to be carried in every train.

11. India-rubber or other inflammable insulating materials to be avoided as much as possible and the outer covering of cables to be uninflammable material that will not give off smoke.



Railway. Underframe for Trailer Car.

12. Means to be provided for enabling the driver at any part of the tunnel to put himself into telephonic communication with the adjacent stations.

In addition, the Board of Trade have arranged with the London County Council that at the Board of Trade inspections of any underground electrical railways the Railway Company shall produce an expression of opinion from the Chief Officer of the Council's Fire Brigade as to the efficiency of the provision made against fire.

The minimum requirements agreed to between the Board of Trade and the Council are :—

1. A hydrant of the Fire Brigade pattern is to be fitted at each end of each platform, and such hydrant is to be provided with sufficient hose and ¾ in. nozzle to reach the whole length of the platform and of the longest train in use on that particular line.

2. At least six buckets of water and six of sand to be available on each of the several platforms.

3. An extincteur is to be supplied to each carriage and to each lift.

It is also recommended that provision should be made for

4. Some experienced person to be responsible to the owners of the railways to periodically inspect and report to the companies on the fire appliances and to test the extincteurs, and the owners are to be responsible for the good order of all such appliances and for seeing that the railway staff is stationed and drilled.

5. All waste and dirt are to be removed at least daily.

6. It must be clearly understood that unless overcrowding in the lifts and carriages is prevented and the gangways of the latter kept clear, the extincteurs in the lifts and carriages will probably prove to be useless in case of fire.

7. It should be borne in mind that in the event of fire obtaining any hold in a tube railway, the Council's Fire Brigade could be practically of no avail, and therefore the railway authorities must rely on their own resources.

The Board of Trade are recognised by railway companies as the authority on railway working. Their advice is always sought before any new system of working is introduced or any existing system altered. Their sanction is obtained before any modification is made to block-working, and any new form of signalling is submitted to them. They take an interest in all matters affecting the working of trains, and their advice is sought about continuous brakes, automatic couplers, either-side brakes, fog-signalling, etc.

Relation of the Board of Trade to Railways with regard to accidents.

Reference has already been made, when quoting the Act of 1871, to those accidents that have to be reported to the Board of Trade.

By the Board of Trade Order of October 31st, 1895, it is specified that all fatal accidents, whether to passengers, servants of railway companies or other persons, shall be reported to them within 24 hours of their occurrence, by telegraph or otherwise. Non-fatal accidents to be reported by post as early as possible.

Non-fatal accidents to servants of railway companies to be reported whenever they are such as to prevent the servant injured, on any one of the three working days next after the occurrence of the accident, from being employed for five hours on his ordinary work.

According to the general report to the Board of Trade upon the accidents on railways for the year 1903 (Blue Book Cd. 2085) the non-fatal accidents to railway servants are in future to be divided into severe and trivial cases. The original demand as to reporting cases where the men are absent for five hours still stands, and the Board are to be informed of any case where such absence extends to 14 days.

They also require to be advised of any accident of the following nature :—

1. As regards the locomotive power and rolling stock.

a. The bursting of any boiler.

b. The failure of a rope used in working an incline.

c. The failure of a wheel or tyre.

d. The failure of an axle.

e. The failure of the hornplate of an engine.

f. The failure of the axle-guard of any vehicle in a passenger train.

g. The failure of any other part of locomotive engine, tenders or vehicles not included in the above, which leads to an accident to a passenger train.

Any return of the failure of a boiler, a tyre, an axle, should be accompanied by a diagram with particulars of construction and failure and by a description of the nature of the materials it is made of and the amount of work it has performed. Failures of tyres and axles should be on forms approved by the Board of Trade. (See below.)

2. As regards the permanent way and works.

h. The fracture of a rail in the permanent way of a passenger railway.

i. The "bursting" of the permanent way under a train on a passenger railway.

k. The failure of a bridge, viaduct or large culvert or of any part of them.

l. The failure of a tunnel or any part of it.

m. The failure of the roof or any important part of a station.

n. Important slips in cuttings or embankments.

o. The failure of a revetment wall.

p. The flooding of a portion of the permanent way.

q. The failure of any portion of the permanent way or works not included in the above which leads to an accident to a passenger train.

In any return of the fracture of a rail the form of the rail should be stated, the weight per yard, the material it was made of, the length of its service, the manner in which it was fixed, and, if a double-headed rail, whether it had or had not been turned at the time it failed.

3. Miscellaneous accidents to rolling stock and permanent way, such as

r. A train travelling in the wrong direction through points on the main line of a passenger railway.

s. An engine or train running over any horse, beast or other obstruction, or through the gate or gates of a level crossing on a passenger railway.

t. Any fire in any part of a train, or at a station, or involving injury to any bridge or viaduct on a passenger railway.

(To be continued.)

The Leitner-Lucas System of Electric Train-Lighting.

THE problems involved in modern Electric Train Lighting are far more difficult to solve than appears at first sight. Each railway coach, or group of coaches, must possess its own miniature continuous current generating station that has to be, while at work; independent of all human care, and must therefore do its work automatically. This "generating station" has to be packed in a small space under the coach; it is subjected to jolting, vibration, to dust and grit.

The work it has to perform is the most arduous imaginable: it has to meet the widest fluctuations of load and to supply the

most irregular demands. The "prime mover" in this "generating station" on wheels—viz., the axle of the coach—revolves sometimes in one direction, sometimes in the other, sometimes slowly, sometimes very fast, and at times not at all. Efficiency too must be studied. Crude methods that in the past may have done indifferently well, with constant adjustments, to supply a few lights at a relatively great expenditure of power, cannot be thought of for modern requirements when coaches, as for example on some German express trains, are lighted each with over 500 c.p. in 3½ to 4 watt incandescent lamps.

It is with the fullest considerations of all the problems that were to be solved and of all the requirements of train lighting that the Leitner-Lucas system has been evolved by the Accumulator Industries, Ltd., at Woking, and for whom Messrs. G. D. Peters and Co., Moorfields, London, are the sole selling agents.

The absolutely automatic and reliable nature of the apparatus of this system is being demonstrated in a striking manner on some English railways by the test of sealing up for three months the commutator cover and oil well of the dynamo and the tray in which the accumulator battery is carried.

The Leitner-Lucas Electric Train Lighting System is applied to independent single railway coaches or groups of coaches. The system consists of a variable speed dynamo and automatic switch, and a single battery of accumulators. The voltages for which stock equipments are furnished are from 16 volts to 48 volts. The usual voltage employed in England is 24-25 volts.

The Dynamo, shown complete and in parts by figs 1 and 2, is usually suspended under the carriage frame and driven from one of the carriage axles.

The dynamo may be driven by belt, chain or gearing. The principles on which it has been designed are that it should, in conjunction with an accumulator battery, give an output of a constancy suitable to the battery within the widest limits of speed. Thus machines have been made with a range of from 400 to 3,000 revolutions per minute, and were it not for the mechanical difficulties arising from great speeds there is no reason why the range should not be as great as from 1 to 15. In practice the dynamos are generally arranged to excite and "cut in" at about 500 revolutions per minute; their normal speed under working conditions rarely exceeds 1,500 to 1,800 revolutions. The inventors of this system do not employ any mechanical devices such as a slipping belt, slipping clutches,

Fig. 1.

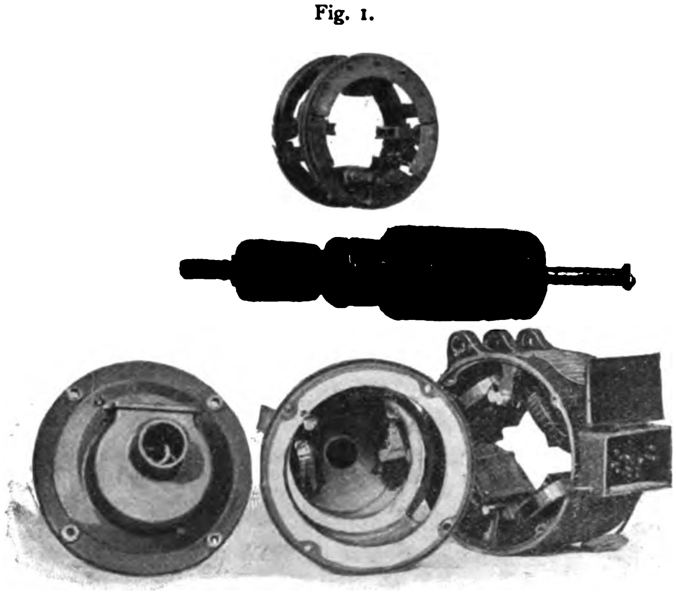


Fig. 2.

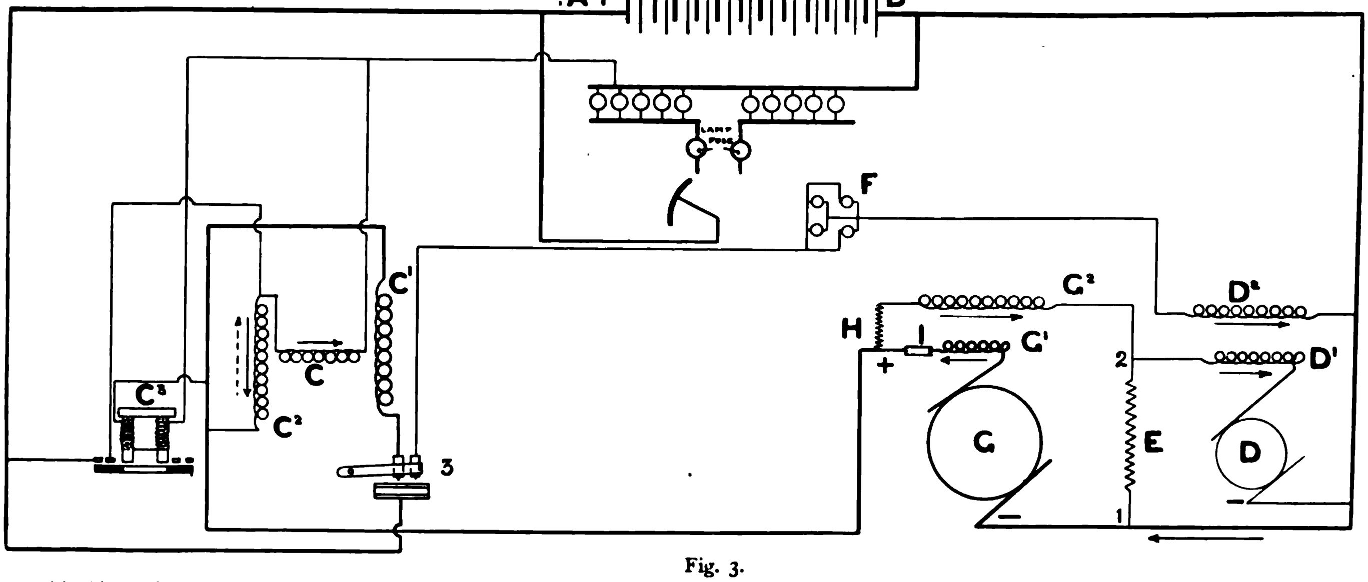


Fig. 3.

A, Battery positive (+); B, Battery negative (—); C, Armature of automatic cut-in and cut-out switch; C¹, Series coils of automatic switch; C², Fine wire of automatic switch. These coils are short-circuited through series windings, when generator is cut in, that is, when it charges the battery. C³, Relay controlling auto-switch; D, Demagnetizer armature mounted on same shaft as G; D¹, Demagnetizer series field; D², Demagnetizer shunt field; E, Thin iron wire lamp resistance to react on generator field circuit by reason of its marked positive temperature coefficient; F, Carbon lamp resistance (negative temperature coefficient resistance), in series with D²; G, Generator armature; G¹, Generator series, wound in reverse direction to G²; G², Generator shunt field, ——➤ shows direction of current; H, Fuse in generator shunt field circuit; I, Main fuse.

automatic speed gears, or any electro-mechanical devices which by means of resistances inserted in the "field" circuit weaken the latter as the speed or output increases, neither do they use any separate motor driven boosters or exciters.

The Leitner-Lucas dynamo is entirely self-regulating in its own windings. Referring to diagram, fig. 3, G and D represent two armatures mounted on the same shaft. G is the main armature and D is a subsidiary and very small armature, which may be termed the "demagnetizer." G^2 is the shunt field of relatively low resistances exciting the field magnets of the armature G, and G^1 is a reverse-compound or negative series field winding. G^1 and G^2, when G is furnishing current, are therefore differential. G^2 branches out at (2) into two paths, viz., D^1 and E; D^1 continues through D and forms the compound series field winding of which D^2 is the shunt winding for the armature D. The second path for the continuation of G^2, namely E, is a resistance having a marked positive temperature co-efficient, such as iron wire preferably, in the shape as used for Nernst lamp resistances, of which several are put in parallel.

In whichever direction the shaft, carrying armatures G and D, may be mechanically revolved—a reversing device naturally makes the correct changes of contact—the current generated by G has the tendency to drive D *in the same direction* as a high speed motor. When the shaft is revolved slowly the back electric motive force of D will be slight, and the E.M.F. across (2) and (1) will not be great, and the choking effect of E will be slight. Therefore the two paths still remain practically open to the field current passing through G^2. As, however, the speed increases, the back E.M.F. of D and the E.M.F. across (2) to (1) increase, and therefore less and less current can pass through G^2. At a certain still higher speed the back E.M.F. of D^1 balances G^2. This "choking effect" of E is now considerable, and at still increased, and as a matter of fact *very high* speeds, not frequently attained in practice, D acts as a reverse compound wound generator putting a feeble current through E, and thus still further increasing the choking effect of E and enfeebling G^2. It will thus be seen that as the speed increases the generator field G^2 decreases, and the output of G remains practically constant over a great part of the curve which has actually descending characteristics to any desired degree after a certain maximum speed.

The reverse-compound winding G^1 also acts in a regulating sense to safeguard against excessive current being generated. It should here be noted that a discharge from the battery into the dynamo, even if it could occur for longer than momentary periods, would not reverse but only confirm the correct polarity of the fields, as G^1 would then act together with G^2, and the machine would constitute a compound wound motor.

The shunt field winding D^2 for the "demagnetizer" armature D passes through the parallel resistances F, which consist of 2 to 4 ordinary incandescent lamps. Their function is to act on the field D^2 by virtue of their negative temperature co-efficient, which brings about that any rise of voltage in the main circuit increases more than proportionately the field D^2, and therefore increases the checking or choking back effect of D.

It will be plain that by adjusting E and F the output of the dynamo may be adjusted to any desired amperage within the limits of the safe carrying capacity of the armature winding in G. The less the resistance E the greater the output of the machine, and the less the resistance F the less the output of the machine. Also by varying the amount of resistance between E and F *short range* output curves and curves with a peak at the average speed of any train, falling off rapidly on the higher speeds, can readily be produced. These latter advantages or refinements cannot be attained in a variant of the Leitner-Lucas dynamo, the somewhat simpler connexions of which are represented in fig. 4. In this variant the shunt field winding G^2 of main generator armature G passes direct through the "demagnetizer" armature D and has no alternative path. The main current from G does not pass through a reverse compound winding, but going straight to the accumulator battery, A-B returns and branches out into D^1 and E and goes back to D and G. D^1 forms the field winding for the "demagnetizer" armature D, which reacts on being revolved on G^2 by means of counter E.M.F. in very much the same manner as described above. E. is a stout iron wire. Any rise of current in G produces a rise in the magnetic saturation (which is low) of the field of which D^1 is the winding, and thus through D this rise in G is instantly counterbalanced. E

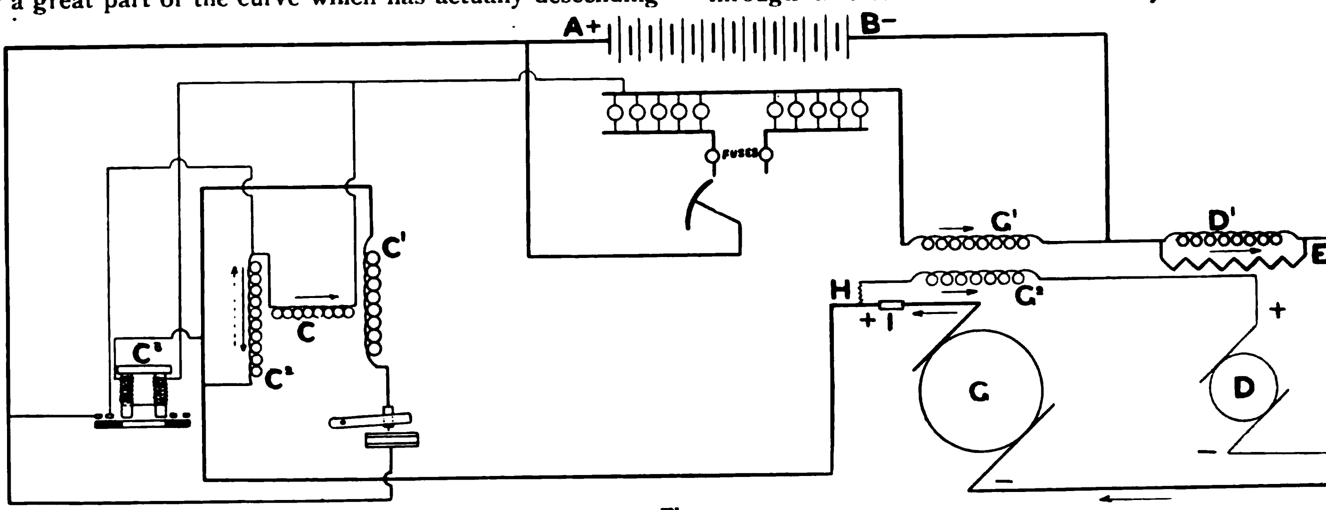


Fig. 4.

A, Battery positive (+); B, Battery negative (−); C, Armature of automatic cut-in and cut-out switch; C^1, Series coils of automatic switch; C^2, Fine wire of automatic switch; C^3, Relay to connect cut-out; D, Demagnetizer armature mounted on same shaft as G; D^1, Demagnetiser field coils carrying main current; E, Iron shunt to vary output of machine; G, Generator armature; G^1, Series wire carrying lamp current; G^2, Generator shunt field; H, Fuse in generator shunt field circuit; ——➤ Direction of current; I, Main fuse.

having a marked positive temperature co-efficient shunts more (or less) current through D^1, and thus enhances the desired effect very greatly. By making E of low or of high resistance the output of the machine can be fixed at a high or low value according to desire without affecting its self-regulating qualities or its speed range. The series winding G^1, which before, fig. 3, was a reverse compound winding, is, in fig. 4, in series with the lamp circuit in such a manner that, should the residual magnetism of the fields have been lost or reversed, the mere fact of switching on the lamps will give an initial excitation to the fields with the correct polarity.

As regards the brush and reversing gear, it has been found in practice that even with the best carbon brushes a fixed "no lead" position does not give good results. The brushes are accordingly mounted on a rocker, which is automatically revolved through the correct angle when the direction of rotation of the dynamo is reversed. With such an arrangement any desired *forward lead* can be given for either direction of rotation.

The Battery of Accumulators consists generally of 12 cells (for 24-25 volts) and is carried in an enclosed tray under the carriage. Fig. 5 shows one of the cells.

The Automatic Switch.—This is shown at C in the diagrams figs. 3, 4, and 5.

When the dynamo has reached the requisite voltage, which must be greater than that of the battery, then C, which is a small H armature having a lever attached to it, establishes the contacts at 3 by turning through a small angle. A relay C^3, which is connected in parallel with the fine wire Field coil C^2 of the automatic switch across the generator terminals, controls the action of this switch.

When the generator voltage is of sufficient value the relay attracts its armature, and the Field coil C^2 is thus put in series with the dynamo and battery; if, however, the E.M.F. of the latter be greater than that of the dynamo the effect is to hold the switch open.

When the E.M.F. of the dynamo is the greater the switch is closed by the reversal of the current in C^2.

It will be noted that this allows the heavy wire Field coil C^1 to short-circuit C^2, and C^1 continues to hold the switch "in" until the dynamo no longer sends the current through the battery.

The relay continues to hold up when the switch opens, and is forcibly held in that position until the voltage of the dynamo falls low enough for the relay armature to drop.

To accomplish this the voltage has to drop to about one-fourth of the cutting-in voltage of the H armature, C and to one half of the "on" position of the relay C^2.

Although at this stage the contact lever is not forcibly held off by current it remains in the "off" position until C^3, C^2 and C are again energised.

The automatic switch is differential and depends for its action upon the difference between the voltage of the dynamo and that of the battery; the purpose of the relay is to cut out the switch when the dynamo is at rest, and thus prevent waste of energy.

Accumulators.—The necessity for a battery of accumulators is a two-fold one, first, to keep the lights going when a train is stationary or running very slowly, or when the dynamo is for any other cause out of action; secondly, to provide an

Fig. 5.

approximately steady load for the dynamo, which is not designed as a constant voltage *open circuit* machine. The practice that has been frequently adopted, of employing two batteries, sometimes coupled in parallel, is bad in theory, and entails the necessity of handling and maintaining double the number of cells; accordingly this practice has never been employed in the Leitner-Lucas system. Paying regard to the extremely arduous nature of the work required from a train lighting battery, a special type has been designed, wherein "improved cellular" Planté positive and pasted negative plates are used. These cells, which are made to the designs of Mr. Henry Leitner by the Accumulators Industries, Ltd., at Woking, are illustrated by fig. 5.

The containers are of lead-lined dove-tailed teak boxes, with rubber flanged lids bolted down. The quantity of electrolyte is calculated on a scale to do away with the necessity of too frequent "topping up," and devices for readily determining its level and specific gravity have also been adopted. It is claimed that this type of accumulator is to be preferred for practical reasons to any form of "light" cell in ebonite containers.

As no system of electric train lighting has been or is likely to be devised without the use of accumulators, and as any defect in the latter militates completely against the proper working of the system from the travelling public's point of view, too much care and thought cannot be bestowed on the design and construction of the battery.

The Regulator.—This apparatus forms a useful adjunct to the Leitner-Lucas system of train lighting, though *it is not part of or essential to the dynamo.* The object of it is to counteract the rising and falling voltages of the accumulator battery when on charge or discharge respectively, so as to keep the lamp voltage constant independently of the number of lamps that may at any time be in circuit. An additional function of the regulator consists in rendering the dynamo nearly or quite inoperative (which determines its being cut off automatically from the accumulators) when the latter are fully charged, that is, have reached the predetermined maximum voltage of 2·8 volts per cell on charge. By the use of this apparatus a more efficient and uniform light is obtained, and a saving is effected in the expense for lamp renewals, especially where the conditions of service include a great deal

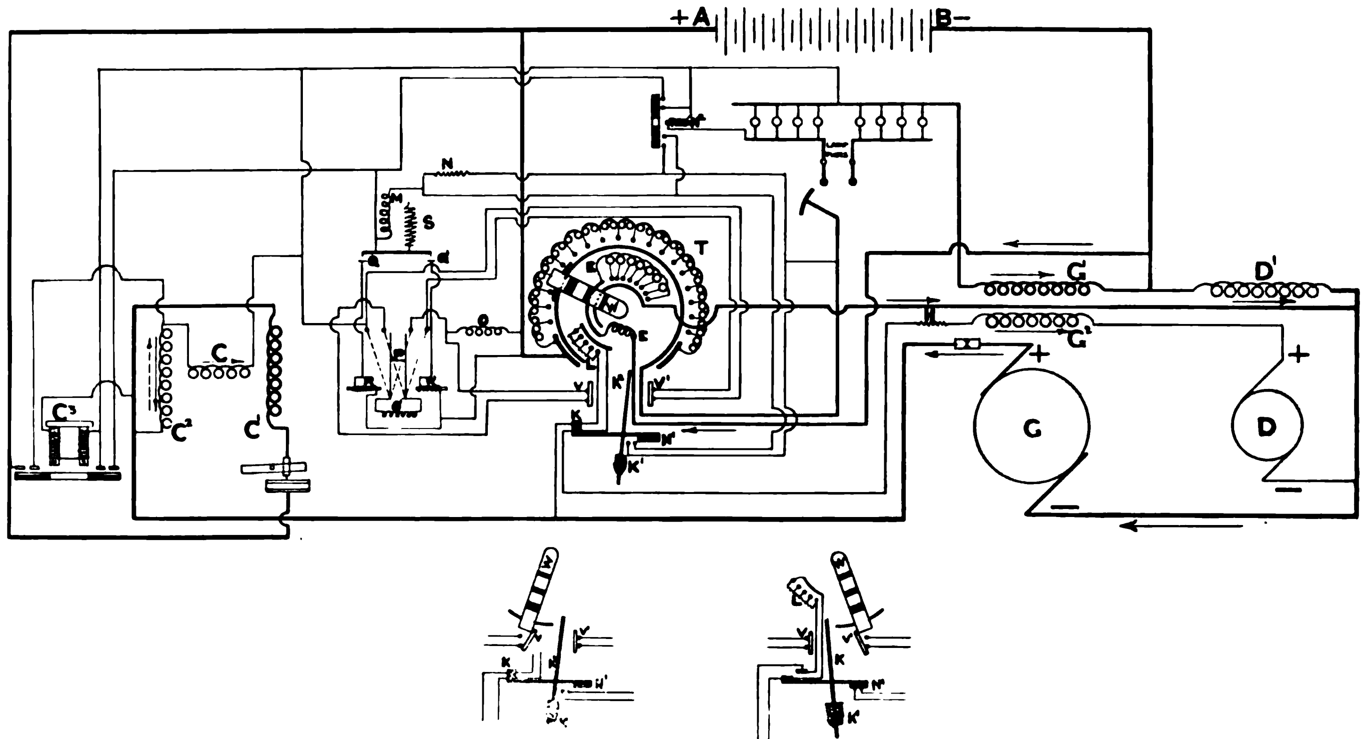


Fig. 6.

A, Battery positive (+); B, Battery negative (−) C, Armature of automatic cut-in and cut-out switch; C^1, Series coils of auto-switch; C^2, Fine wire of auto-switch. (These coils are short-circuited through series windings when generator is cut in, that is, when battery is being charged.) C^3, Relay to connect cut-out and automatically switch on voltage balance; D, Demagnetizer amature mounted on same spindle as "G"; D^1, Demagnetizer field coils carrying current shunted from E, which consists of iron wire and carries the main current. (As current rises resistance of iron wire is increased, thus shunting a greater current through D^1.) G, Generator armature; G^1, Generator series wire carrying lamp current; G^2, Generator shunt field; H, Fuse in shunt field circuit; I, Main fuse; K, Quick make-and-break switch in shunt field circuit, automatically operated by regulator when battery is fully charged, re-establishing circuit when battery requires to be re-charged: K^1, Spring for quick-break switch; K^2, Lever for operating quick-break switch K and switch N^1; L, Resistance automatically switched in series with main shunt field when K has operated. (Resistance L is gradually short-circuited when shunt field is re-made.) M, Voltage balance or contact voltmeter; N, Resistance in series with voltage balance, short-circuited when shunt field is broken or lamps switched on; N^1, Switch for automatically short-circuiting resistance N when shunt field is broken; N^2, Relay to switch on voltage balance and short-circuit resistance N when lamps are switched on; O, Armature of series motor for actuating patent regulator; O^1, Field coils of motor; P, Reversing switch, automatically operated by relays; QQ^1, Contacts of voltage balance for operating relays; RR^1, Relays for operating reversing switch of motor O; S, Spring of voltage balance; T Resistance automatically switched in or out of the lamp circuit with the slightest variation of voltage: VV^1, Switches to automatically break circuit of motor O when regulator arm W has moved completely round in either direction. The switch V breaks the motor circuit that would cause the motor to move arm further in the counter clock-wise direction, but not the circuit which, when the lever has reached the limit of its counter clock-wise travel, would move it clock-wise and away from V. The switch V^1 acts in precisely the contrary sense when the lever has reached the limit of its clock-wise travel. W, Contact arm of regulator. The small figures show the regulator arm in each of its extreme positions.

of "daylight running" with lamps out. The needless, if not harmful, excessive overcharging of the battery is prevented, which results in a saving of energy, less wear and tear of dynamo and accumulator plates, and above all in far less evaporation or rather "gassing away" of the electrolyte, and its attendant cost for upkeep of cells.

The regulator is shown diagrammatically by fig. 6. M is a solenoid acting as a contact voltmeter, energizing either of the relays R and R^1, through contacts Q or Q^1. These relays in their turn cause a miniature motor, of which O is the series field winding ond O^1 the armature, to rotate either in one direction or the other; this rotation moves an arm over the rheostat T, which is in series with the lamp circuit. At one end of the travel of T the shunt field G^2 of armature G is either completely broken or much increased in resistance, so that the cut-out C disconnects the dynamo from the accumulator battery. The contact voltmeter, also termed "voltage balance," acts on a lower or higher voltage scale by means of the addition or omission of resistance N in series with it, and according to whether lamps are on or off, and whether the dynamo is charging or not. The Lucas-Leitner system is now in use upon the L. and North-Western, the Great Western, the Great Central, and other railways.

Official Reports.

Between **Llanelly and Loughor, G.W.R.,** *on 3rd October. Lieut.-Col. H. A. Yorke, R.E., reports that:—*

The 10.35 a.m. passenger train (2 engines and 9 coaches) from New Milford was suddenly derailed at 2 miles 1,095 yards east of Llanelly. The leading engine was overturned, and the front portion of the train completely wrecked.

The driver and fireman of the leading engine and 3 passengers were killed and 94 passengers were injured.

The tank engine (leading) and the tender of the train engine were overturned, and both the engines and the tender were damaged, but not so seriously as might have been expected. The first carriage was entirely wrecked, the steel underframe being broken up and separated from the body, which was lying at the foot of the embankment outside the down line; the second had its steel underframe bent and buckled, and the side of body smashed; the third had three compartments at one end smashed in; the fourth had one end broken in; the fifth and sixth were slightly injured; while the seventh, eighth and ninth were practically undamaged.

The permanent way of the up line was disturbed or torn up for a length of 105 yards, of which 67½ yards were completely destroyed. The down line was pushed out of place and partly destroyed for a length of 70 yards (see fig. 1); 18 rails of the up line were bent, and one was broken; 4 rails of the down line were bent; 72 sleepers and 100 chairs were broken, and 30 sleepers were slightly damaged.

The line is on an embankment about 6 ft. high, which rests on a bed of clay 6 ft. thick.

The permanent way, which was laid in 1887, consists of bull-headed steel rails, weighing originally 86 lbs. per yard and which now weigh 81·93 lbs., chairs weighing 46 lbs. each (present weight 45 lbs.), and creosoted sleepers of the usual dimensions, there being 12 sleepers to a 32-ft. rail. The chairs are each fastened to the sleepers by two fang bolts, which pass right through the timbers. The road is well ballasted, and the space between the up and down lines, usually called the 6-foot way, is 11 ft. 2 ins.

In the summer of 1902 a certain number of the sleepers which were found to be defective were taken out and renewed, and shortly afterwards the old fish plates, which weighed

about 28 lbs. per pair, were removed, and new plates weighing 32½ lbs. per pair were put in their place.

The leading engine (see fig. 2) was a six-wheels-coupled saddle tank engine, with a maximum weight, when full, of 47 tons 18 cwt., made up as follows, according to the information supplied from Swindon :—

	tons	cwt.	qrs.
Weight of engine empty ...	37	12	0
1,080 gallons water in tank	4	16	2
Coal in bunker	2	10	0
Coal in firebox	0	3	0
Sand in boxes	0	3	2
Water in boiler	2	13	0

the distribution of weight being—

	tons	cwt.
On the two leading wheels ...	15	14
On the middle wheels	15	14
On the trailing wheels	16	10

But the probability is that, at the time of the disaster, the engine had not the full amount of coal in the bunker, sand in the boxes, or water in the tank, and the actual weight may be taken as not more than 46½ tons.

The diameter of the wheels, when new, was 5 ft. 2 ins., and the wheel base was 15 ft. 9 ins., divided thus—between the leading and driving wheels 7 ft. 9 ins., and between the driving and trailing wheels 8 ft. The length of the engine over the buffers is 30 ft. 2¼ ins., and exclusive of the buffers 26 ft. 8¼ ins. The centre of gravity of the boiler and saddle tank combined is 6 ft. 11½ ins. above rail level (see fig. 2), but the height of the centre of gravity of the engine, as a whole, cannot be given, as it is a very complicated matter to solve without actual experiment. It is, however, evident that when the weight of the wheels, frame and machinery is taken into account, it is much lower than that of the boiler and tank by themselves. But it should be noted that, whatever the height of the centre of gravity of the engine as a whole may be, its position in relation to the wheel base of the engine is, owing to the distribution of weight on the axles, about four inches behind the driving axles when the bunker and tank are full. When, however, the bunker is half empty, and some of the water out of the tank, the centre of gravity is a little in front of the driving axles.

The engine is double framed, and the driving wheels have inside and outside bearings, journals, and springs. These bearings have a tight fix on the axles, and have very little side play. The cylinders are 17 ins. by 26 ins., the working pressure 140 lbs. to the sq. in., and the tractive force, or draw bar pull, is 15,270 lbs. The engine was built in 1886, and had been thoroughly overhauled and repaired in the Neath locomotive shops during the six months June-December of 1903. New tyres were then fitted to the wheels, and it is said to have left Neath in the latter month as good as new. It had run 15,000 miles since leaving Neath, which is about one-third of the usual mileage run by an engine before again requiring general repairs.

This engine, which was overturned on its right side, had, after the accident, nothing whatever wrong with its wheels, springs, axles or machinery, with the exception that the spring hangers of the right hand leading wheel were badly bent, and the coupling rod between the right hand leading and middle wheels was broken close to the crank pin of the foremost wheel. There is no doubt that the bending of the spring hangers was due to the overturning of the engine, but as regards the fracture of the coupling rod, it is open to doubt whether this took place before the accident, or as the result of it.

The coupling or side rods are the original ones fitted to the engine in 1886, and are said to have been submitted to the usual hammer test while the engine was at Neath, and found free from flaws or cracks. They are of the best fagotted iron, and specimens cut from the broken rod have been tested since the accident with most satisfactory results.

Each of the side rods is in two portions, the joints being behind the crank pins of the middle wheels. The rod which broke was the front side rod on the right hand side of the engine, the fracture occurring five inches from the centre of the crank pin of the leading wheel (see fig. 2). The side rod is 7 ft. 9 ins. long between the centres of the leading and driving crank pins; 4½ ins. deep and 1½ ins. thick in the centre; and 3½ ins. deep and 1½ ins. thick at the neck. These dimensions are slightly less than those used upon modern engines, in which the depth is 5½ ins. in the middle, and 4½ ins. at the neck, the thickness throughout being 1½ ins., but the factor of safety in the broken side rod works out at 4·2, as against 4·5 for the modern rod, so there is but little difference between the two in point of strength. The section of the rod at the point where it broke is 3⅜ ins. by 1 9/32 ins. The ends of the side rod are welded to the body of it, and the fracture was situated between the weld and the end of the rod, and apparently outside the influence of the weld. The appearance of the fracture was good, that is to say close grained, over two-thirds of its surface, but the middle portion was rather coarsely crystalline. A close examination of the fracture in the laboratory at Swindon disclosed no signs of any previous flaw, the appearance being such as might be due to a sudden fracture caused by a blow or shock.

The train engine was a 4-coupled express passenger engine "Montreal" with a leading bogie and a 6-wheeled tender. The weight of the engine when full was 51 tons 18 cwt., and of the tender 34 tons 5 cwt., the weights being distributed as follows :—

Engine.	Tons cwt.	*Tender.*	Tons cwt.
On the bogie wheels ...	17 12	On the leading wheels...	12 1
On the driving wheels...	17 14	On the middle wheels...	11 0
On the trailing wheels...	16 12	On the trailing wheels...	11 4

The diameter of the coupled wheels when new was 5 ft. 8 ins., and of the bogie wheels 3 ft. 8 ins. The distance between the bogie wheels is 6 ft. 6 ins., between the bogie pin and driving wheel 7 ft. 3 ins., and between the coupled wheels 8 ft. 6 ins. The wheel base of the tender is 13 ft. The total length of the engine and tender over the buffers is 54 ft. 1¾ ins. The centre of gravity of the boiler, exclusive of the rest of the engine, is 7 ft. 2½ ins. above rail level. The working pressure is 195 lbs. to the square inch, and the tractive force 21,741 lbs., the cylinders being 18 ins. by 26 ins.

This engine remained on the up track with its four coupled wheels on the rails, which were slightly out of place. The tender was separated from the engine and turned over on its side, fouling both the up and down lines.

They were not in any way responsible for the derailment.

The only wheel marks found were those commencing at the spot marked A on fig. 1, which indicate that a wheel mounted the right hand rail at that place, and after travelling diagonally along the rail for a distance of about 6 ft. dropped off the rail into the six-foot way. The left hand wheel on the same axle followed a parallel path and dropped off its rail into the four-foot way at a spot 9 ft. 7 ins. from point A, leaving a clear grazing mark on the inside of the rail where it dropped off.

The right hand wheel after dropping off the rail grazed and indented the chairs on the next three sleepers, and reaching a rail joint between the sixth and seventh sleepers from A, sheared off the heads of three fish bolts on the outside rail, leaving one fish bolt unbroken. Both wheels continued to diverge further and further from their respective rails, breaking the chairs and indenting the sleepers, until at the 28th sleeper from A the right hand wheel got clear of the sleepers and dropped into the ballast in the six-foot.

The marks on the next six sleepers were not observed, and beyond the 34th sleeper from point A the up line was torn up and destroyed for a distance of 67½ yards, being then slightly disturbed for a further length of 17 yards. The total distance from point A to the front of the train, after it had come to rest, was 105 yards. About 20 yards east of the 34th sleeper, or 46 yards from point A, the down line was displaced and damaged, the whole track being pushed out of alignment for a distance of 70 yards, so that the ends of the sleepers and the outer rail overhung the edge of the embank-

ment, and part of the inner rail was ripped up and twisted in various directions, one length of it being found curled up over the cab of the train engine. From the appearance of the wheel marks, that is to say from their depth and width, and from the clean way in which the heads of the fish bolts were sheared off, the marks were caused by the wheels of an engine, and, if so, by the leading wheels of the tank engine.

This case is for several reasons one of unusual difficulty, and the evidence is voluminous, but the result of the investigation is disappointing, for although every effort has been made to discover the cause of the derailment, no direct evidence is forthcoming, and any conclusions arrived at depend upon theoretical considerations rather than upon absolute proof.

One of the most noticeable features of the occurrence is the absence of any physical conditions such as are usually found in cases of this nature. Here there is no question of curves, super-elevation, or gradients; the line was quite straight and on a dead level.

There is no doubt that the leading engine was the first to leave the rails.

The train weighed 196 tons, and inclusive of engines

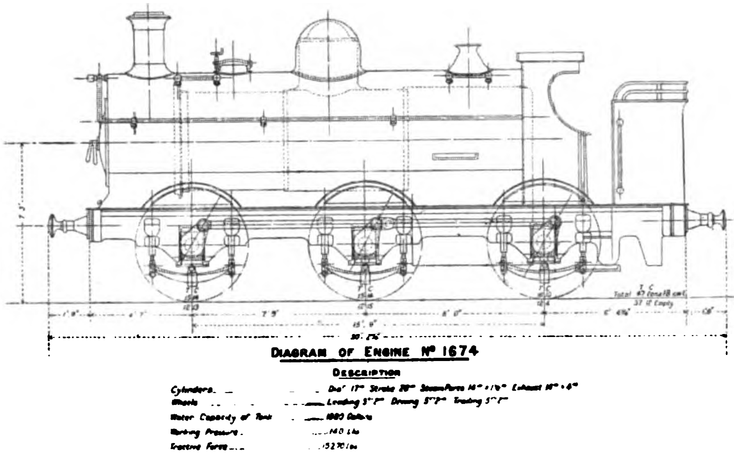


Fig. 2.

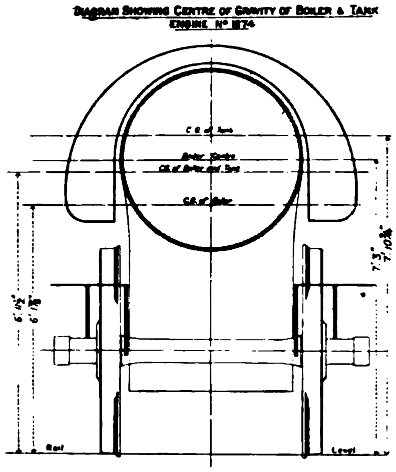


Fig. 3.

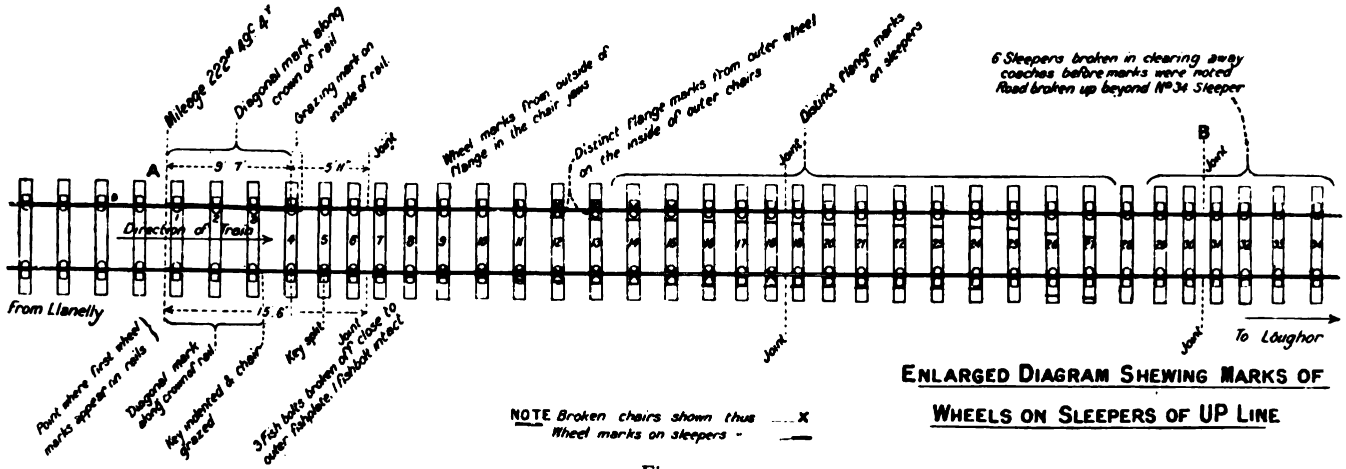


Fig. 1.

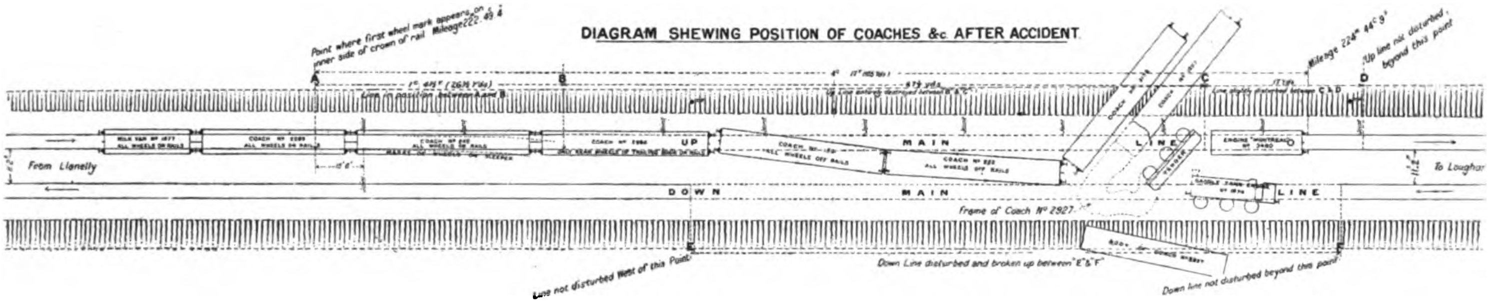


Fig. 4.

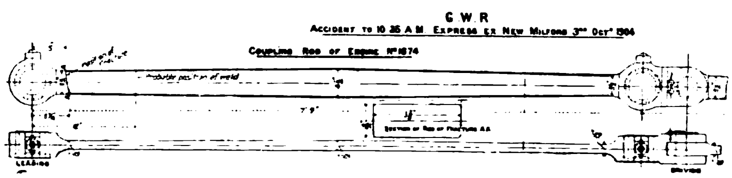


Fig. 5

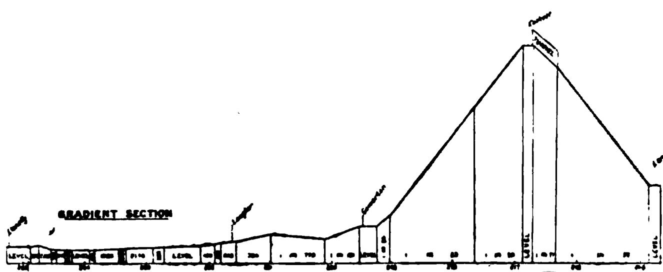


Fig. 6.

327 tons 15 cwt. It was well filled, the guard's statement being that it contained 300 passengers. From New Milford to Llanelly it was drawn by the "Montreal," a nearly new express engine. At Llanelly an assistant engine was attached in front of the "Montreal" to help it up the Cockett bank, which is situated between Gowerton and Cockett about six miles east of Llanelly, this engine being what is known as a six-wheels-coupled, saddle tank engine (see fig. 2).

The train left Llanelly at 1.15 p.m., being then 7 minutes late.* From an examination of the marks on the plan (see fig. 1) the following appears to have been the sequence of events:—

When the leading wheels, after mounting the rails, dropped on to the sleepers, the engine took an oblique course to the right, *i.e.*, towards the down line, until the right leading wheel got clear of the sleepers, and dropping on to the ballast in the 10-foot way, became more or less imbedded therein. When this occurred, it is probable that the engine overturned on to its right side. The engine was then partly across the up line, and, offering a direct obstacle to the passage of the train, was pushed aside by the second engine until the front of it (the leading engine) came into contact with the left-hand rail of the down line, causing the whole down track to be forced out of position and to overhang the edge of the embankment. As the train engine forced its way past the end of the overturned engine the latter was gradually swung round, until, by the time everything had come to rest, it was lying partly on the down line, and partly in the space between the up and down lines, and roughly parallel with them, with its front end pointing to the rear.

It is important to note that though the bogie wheels of the train engine were off the rails, the coupled wheels were not derailed, and the permanent way below the engine was only slightly disturbed, evidently by the bogie wheels. This fact goes to prove that the leading engine did little damage to the up line, being soon pushed clear of it, and that the train engine never left the rails at all except as to its bogie wheels. It follows from this that the destruction of the up line behind the train engine was caused by the overturning of the tender, by the crumpling up of the frame of the first coach, and by the derailment of the three next coaches of the train.

The speed of the train was probably between 50 and 60 miles an hour.

The time allowed between Llanelly and Loughor for passenger trains booked to stop at those two places, as given in the Service Time-book, is six minutes from time of departure to time of arrival for the distance, viz., 3 miles 1,100 yards, between these two places, which gives an average speed from start to finish of about 37 miles an hour. But deductions as before of 1½ minutes at the beginning of the journey and one minute at the end of the journey have to be made to represent the loss of time due to starting and stopping, which leave 3½ minutes as the available running time, and the speed of these trains between the two places has consequently to be not less than 60 miles an hour.

What the actual speed was at the time of the derailment cannot be ascertained with certainty. The driver of the train engine puts it at 25 to 30 miles an hour, but seeing that the train had left Llanelly about 5 minutes previously, and had covered a distance of 2 miles 1,095 yards, this estimate is obviously incorrect, if the train was keeping time.

Signalman David Davies, at Llandilo Junction East Cabin, says the train passed him at 1.19 p.m., that is, 4 minutes after leaving Llanelly, at a speed of 25 miles an hour, but this again cannot be correct. The distance between Llanelly and Llandilo Junction East is 1 mile 1,031 yards, and an average speed from start to finish of 23¾ miles an hour would be required in order that this distance might be covered in 4 minutes. But as the train started from rest, the speed at the end of that interval of time, *i.e.*, when passing Llandilo East Cabin, must have been at least 47½ miles an hour in order to give the above average.

* According to "Bradshaw" and other time-tables issued to the public, the time of departure is 1.5; but in the Service time-tables, issued for the guidance of the Company's servants, the time is 1.8 p.m.

This part of the railway had been walked over on the morning of the accident by the ganger and by the permanent way inspector, who both found it in good order and requiring no attention. Immediately after the derailment the line was carefully examined and gauged westwards from the first mark upon the rails by foreman platelayer George Hopes, who found it in good line and in good gauge.

No broken rail was discovered at or near the point of derailment, and I am satisfied that the derailment was not due to any defect or failure of the permanent way.

So far as the train engine (the "Montreal") and the carriages are concerned, it is certain that they were in good order, and suitable for express speeds, and they may be left out of account.

As regards the tank engine, after the accident the axles, wheels, tyres and flanges were in perfect condition, and of this it may be noted that the engine, after being replaced upon the rails, it travelled to Swindon on its own wheels. Its chief defect was the fracture of the right-hand leading coupling rod. Whether this fracture was the cause or the consequence of the accident cannot be stated with certainty. The breaking of the rod would throw the axles slightly out of truth; the right-hand leading wheel would bind against the right-hand rail, which it would tend to mount; the disturbing effect of the broken rod would upset the balance of the wheels, and the engine would begin to lurch or rock. Conditions might in this way arise which, when the speed and the pressure of the train engine behind the crippled engine are taken into account, would in all probability cause a derailment.

But against the theory that the side rod caused the derailment must be set the fact that the driver of the train engine says that, so far as he knows, the side rod of the leading engine was not broken before the latter engine left the rails. It is also the case that the latter fell over on to its right side, *i.e.*, on the same side as that on which the broken side rod was afterwards discovered, and it is possible that the rod was fractured by the capsizing of the engine. Moreover broken side rods, though not uncommon, have been rarely known to cause a derailment. While, therefore, it is not an improbable thing that the fracture of the side rod caused the derailment, there is no proof that this was the case. Failing this, some other explanation of the catastrophe has to be sought.

It has been suggested that the derailment was due to the "oscillation" of the tank engine, and this was the view adopted by the coroner's jury. The oscillation of engines is governed by various factors, of which the speed, the length and nature of the wheel base, the balancing of the wheels, and the distribution of the weight are the principal. In this case the wheel base was rigid and 15 ft. 9 ins. long. The bunker overhung the trailing wheels by 6 ft. 4½ ins., while the front of the engine overhung the leading wheels by 4 ft. 7 ins. The height of the centre of gravity of the tank engine was less than that of the train engine, and very much less than that of some of the heaviest engines now in use upon other railways. But the position of the centre of gravity in relation to the wheels was, when the engine was full with coal, water and sand to its utmost capacity, four inches behind the middle axle, although under normal running conditions, with about half the quantity of coal in the bunker, it is slightly in front of the middle axle. The engine was therefore practically balanced about its middle axle, which seems to be an unsatisfactory arrangement for steadiness of running.

The proper position for the centre of gravity of an engine is in front of the driving wheels, and this seems especially desirable in the case of a saddle tank engine, in the tank of which the water would be for ever surging from one side to the other or from one end to the other. It is evident that when the centre of gravity is behind or over the middle axle there is a greater tendency for the front wheels to be lifted off the rails in consequence of the lurching of the engine, or of any inequality in the permanent way, than if it was in front of the middle axle. Moreover, an engine with a wheel base of 15 ft. 9 ins., and a total length, exclusive of buffers, of 26 ft. 8¼ ins., would be liable to oscillate a good deal when running at high speed, and this would be specially the case

with an engine such as No. 1,674, not only because it had not a tender behind it to steady it, but also because it had a heavy coal bunker overhanging the trailing axle by 6 ft. 4½ ins., which on a straight road would be certain to rock or swing violently from side to side. Although in this case the tank engine was in front of, and attached to, a heavy express engine, which might be expected to have a better steadying effect even than a tender, it cannot be stated with certainty whether the coupling between the two was tight, and unless this was the case the train engine would not have much effect in checking oscillation. The probability is that owing to the speed the "Montreal" was doing all the work, and the coupling between the two engines was slack.

Three witnesses who had knowledge of engine No. 1,674 were questioned with a view to ascertaining whether this engine had an undue tendency to oscillation, and whether they themselves had ever made, or had heard anyone else make, any complaint with regard to the oscillation of this engine. Their evidence in this respect was unsatisfactory and inconclusive, and amounted to little more than this, that tank engines oscillate rather more than tender engines, and one man said that the oscillation of engine No. 1,674 was slightly greater than that of other tank engines. None of them admitted that he had seen engines of this class travel at higher speeds than 30 miles an hour.

These saddle tank engines were designed a great many years ago, and it may be taken for granted that they were never intended for express work. It is probable that they were designed for a speed of 35 or at the outside 40 miles an hour. They are said to be a useful class of engine, and as the Great Western R. possesses 1,143 of them, a great deal of work is done by their means in the course of a year. But the arrangement of their wheels and weights is such as in my judgment to render them liable to oscillation, which at high speeds would become dangerous. It has been shown that the train in this case was timed to run at a speed of about 50 miles an hour between Llanelly and the foot of Cockett Bank, and that the actual speed at the time of derailment may have been as high as 60 miles an hour. If this were the case a dangerous oscillation would in all probability be set up in the tank engine, which might be sufficient to account for the derailment.

Against this suggestion it must be admitted that there is no direct proof that the derailment was due to the oscillation of the tank engine. The absence of any sign of disturbance in the permanent way, such as might be caused by oscillation, may be attributed to the strong construction of the "road," while the two enginemen who could have spoken as to the behaviour of the tank engine both met their death. Driver John Thomas says that Lloyd, the driver of the tank engine, was sitting down just before the accident, which, if correct, may be taken as indicating that no abnormal oscillation existed, and that the unfortunate man had no idea of danger.* It is also the fact that driver Lloyd could have checked the speed of the train if he had thought it necessary to do so, by shutting off steam and applying the continuous brake.

From what has been said it will be gathered that the fault is in some way or other to be traced to the tank engine. The probability is that it was due to one or other of two causes, viz., the fracture of the side rod, or the oscillation of the saddle tank engine in consequence of too great a speed.

Col. Yorke does not regard the saddle tank engine referred to in this report as a suitable engine to be attached in front of a train timed to run at express speed. Mr. Churchward in his evidence says that these engines are safe at 50 miles an hour as the "highest maximum," but in order that a reasonable margin of safety may exist the usual running speed should not be higher than 40 miles an hour. When an assistant engine is required to help a train up the Cockett Bank it should be attached at Gowerton and not Llanelly, unless the assistant engine be an express tender engine. It does not commend itself as good practice to attach an engine designed for moderate speeds to a train timed to run at high speed over a straight and level road. When this is done, one of two things must happen; either the slower engine will cause delay to the train, or will itself be run at a speed which is unsuitable and may become dangerous.

* Col. Yorke doubts the accuracy of this statement.

The knowledge gained in this and other enquiries, in which tank engines of various classes have been concerned, makes it apparent that the question of the behaviour of tank engines of all types and classes, under different conditions of speed, requires investigation, and the Associated Railway Cos. should be invited to appoint an expert Committee for the purpose of enquiring into and reporting upon the subject, after which a classification of these engines might be made according to the work for which each type is found to be suitable.

*

At **Wishaw North Junction, C.R.,** *on 22nd November. Major J. W. Pringle, R.E., reports that*:—

Whilst the 7.10 a.m. down goods train (Carlisle to Mossend) was standing at the down main starting signal at Wishaw North Junction, with the brake van foul of the up branch line, it was struck by the 4 p.m. up passenger train (Glasgow Central to Carstairs).

Signalman Little, of Wishaw North Junction, offered the goods train on the down main line to Carfin Colliery at 4.14 p.m., but it was not accepted. At 4.23 p.m. he allowed the train to draw forward to the down main starting signal on the understanding, apparently, that it would be very shortly accepted. He did not know how many waggons were attached to the goods train, but he verbally instructed the driver, as he passed the signal-box, to draw well clear of the junction with the branch line. He did not repeat these instructions to the brakesmen of the goods train.

Driver Smith heard Little's instructions and understood that his train was required to draw clear ahead of the junction. He went forward therefore until his engine and two waggons had passed the down starting signal and then came to a stand. He received no signal from the brakesmen of the train, and in default of a signal from them to draw further ahead he thought that the tail of the train had cleared the junction. As a matter of fact the trailing wheels of the rear brake van were standing on the crossing, and the whole length of the van was foul of the up branch line.

Goods guard Burgess and his assistant, Foster, who were sitting in the brake van, were quite aware of their position, but, having received no specific instructions to clear the junction from signalman Little, they thought that it was not incumbent upon them to take any action.

The passenger train was offered to Little by Shieldmuir Junction at 4.27 p.m., and he accepted it. At 4.29 p.m. Little, who was persuaded that the junction had been cleared by the goods train, and who states that he could see the junction rails clear behind the brake van, pulled off all the up signals on the branch line for the passenger train. Guard Burgess, fortunately, noticed the up branch line home signal fall, and immediately jumped out of the brake van, and ran down the branch line showing a red light.

Signalman Little, it is obvious, should have waited to receive a hand signal, or communication, that the junction had been cleared, before lowering the branch line home signal to safety. The fouling point was nearly 250 yards distant from him, and it was quite impossible for him to judge by eye whether the line was clear or not.

Although there appears to be no specific rule relative to the conduct of guards under the circumstances described, some action was necessary from guards Burgess and Foster, either to clear the running junction or to protect the rear of their train. An addition should be made to the General Rules to cover the case.

In view of the long distance—about 250 yards—between Wishaw North Junction signal-box and the junction crossing, the addition of a bar on the down main line at the fouling point appears to be advisable.

Editor's Notice.—All manuscripts and communications should be distinctly written, or preferably type-written, on one side of the paper only, and addressed to the Editor, **3, Ludgate Circus Buildings, London, E.C.** The Editor cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped directed envelope.

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The Railway Engineer

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Contents for June.

The Hon. **Reginald Capel**, deputy-chairman of the Great Northern R., has retired from the board and **Lord Balfour of Burleigh** has been elected a director.

Mr. Arthur L. Stride, managing director of the London, Tilbury and Southend R., has been appointed deputy-chairman in succession to the late **Mr. John Warren**, and **Capt. Herbert M. Jessel, M.P.**, and **Mr. Percy B. Trower** have been elected directors.

Mr. Geo. Willans, who was locomotive superintendent of the Wrexham Mold and Connah's Quay R. when it was taken over by the Great Central R., has been appointed assistant locomotive superintendent of the Smyrna R.

Mr. J. F. S. Gooday, general manager of the Great Eastern R., has been appointed to succeed **Mr. Alfred Baldwin, M.P.** (who has resigned), on the Committee on Railway Rates for Agricultural Produce.

Mr. J. P. O'Donnell, chairman and managing director of the British Pneumatic Railway Signal Co., Ltd., has been elected president for the year of the Railway Officials' Association. He presided at the annual dinner at the Criterion on the 13th ult., and, in proposing the toast of the evening, announced that **Mr. Sam Fay** had consented to be his successor next year. This association was formerly known as the London and Suburban Railway Officials' Association, and has in its time done a great deal of good. It was reorganised last year and opened to railway officials all over the country.

We regret to record the death of **Mr. Thos. Matthews**, who was for more than 57 years engineer of the North London R. He was one of the pioneers who set out the line together with its extensive docks at Poplar. Subsequently these works were constructed under his supervision. He was much respected, and his retirement was greatly regretted. He died on the 8th ult., at the age of 86 years.

*

Electric v. Steam Traction.

To the discussion upon the "Reports" on Electric Traction presented to the Railway Congress at Washington Mr. J. A. F. Aspinall, general manager of the Lancashire and Yorkshire R., is reported, in the Official Daily Journal, to have contributed some interesting remarks.

Assuming that he was correctly reported, and his views to be right, the substitution of electric for steam traction will not be of much benefit unless the carrying capacity of the line can be increased thereby.

He stated that his year's experience with the Liverpool and Southport line showed that the operation with electric traction was more expensive than with steam. Consumption of coal was especially greater per ton-mile, but "running" was less because the crews made more miles. One reason for the adoption of electric traction in this instance was the necessity of reducing the train pressure during the busy hours at the Liverpool terminus. An electric train is got into and out of the terminus with half the signalling and shunting. The cost of installing electric traction was £20,000 (or 3½ times that of steam) per mile, and the interest and sinking fund on this sum makes the operation more expensive than steam. The trains were as heavy as steam-worked trains.

Curiously enough just about the same time it was announced here by one of the chief officials of the North Eastern R. that the operation of their electric lines left a fair margin of profit after charging all working expenses and interest on the capital cost of the new plant. And Mr. A. Wilson, of the North Eastern R., who followed Mr. Aspinall in the discussion above-mentioned at Washington, gave the total cost of traction during the month of February at 5·7*d*. per train-mile.

The North Eastern trains averaged 2¾, and the Lancashire and Yorkshire trains of four or sometimes five cars.

Both lines met with the same success, viz., great increase of traffic and receipts.

The comparatively unsatisfactory results from the Lancashire and Yorkshire electric section are not easy to explain, but seem to indicate that the methods in vogue at Newcastle might be closely copied.

*

Italian Railways.

On the 1st July next the Italian Government will take over, and work direct, the railways of the Mediterranean R. Co., and which, together with those of the Southern R. Co. (also being taken over), practically comprise all the main lines in the country.

*

Purchase of the Bombay, Baroda and Central India Railway.

The company announce that formal notice has been given by the Secretary of State for India of his intention to purchase this company's railway under the powers conferred upon him under the contract of February 2nd, 1859, and subsequent contracts.

The purchase price, as determined by the average price recorded in the official list of the London Stock Exchange, has been ascertained to be approximately £154 15s. 5d. per £100 stock, and the purchase will take effect from December 30th next.

*

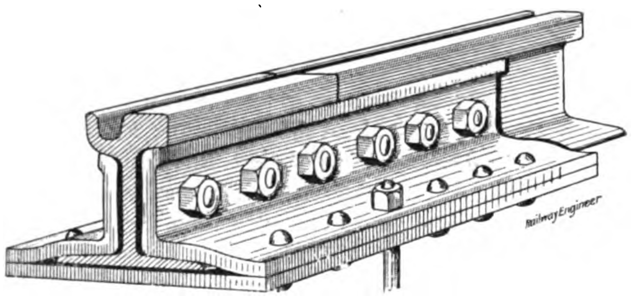
Non-Conducting Ballast for Electric Railways.

ACCORDING to the Liverpool papers the electrified section of the Lancashire and Yorkshire R. between Liverpool and Southport is now being metalled with a very hard, marble-like stone of great non-conductive power. This non-conducting ballast, which will take 3,000 volts without penetration, is spread in a thin coating underneath and between the sleepers, and it renders the live rail perfectly harmless. Under these conditions anyone placing his hands on the live rail or otherwise coming into contact with it receives no shock unless he forms a direct contact between the live and dead rails. This special non-conducive ballast, which is obtainable from a quarry in Teesdale, near Darlington, has already been adopted on the North-Eastern R. electric lines in the Newcastle district with satisfactory effect.

*

Booth's Rail Joint.

MR. H. BOOTH, 84, Parkside Road, Sheffield, has invented a new rail joint which is to be given a trial on the Sheffield Corporation Tramways. A really effective tram-rail joint is badly wanted, for the various "anchoring" arrangements which have been largely used by no means give unqualified satisfaction.



The advantages claimed for the arrangement illustrated are that it gives an increased grip to the head of the rails when cars are passing over the joint; double the ordinary bearing surface where most needed; less costly than sleepers; and freedom from jolting or hammering. Wood or felt packing may be used under the rail if desired, and the joint may be anchored by bolts through the concrete as indicated on the illustration. Shorter chairs may be used between the joints if required, as they probably would be if the joints were bolted down as anchoring seems to induce "hogging."

*

Light Railway Orders.

THE Board of Trade has recently confirmed an order authorising the construction of the *Portsmouth and Hayling Light Railway*, including a conveyor bridge over the Langstone Channel.

The Board of Trade has also amended the *Basingstoke and Alton Light Railway Order, 1897*, as to speed.

And confirmed orders for the construction of the *Guildford Light Railways* in Surrey, and the *Campbeltown and Machrihanish Light Railway* in Argyllshire.

*

New Millsaw File.

MESSRS. WRIGHT, BINDLEY AND GELL, LTD., Sheffield, send us an illustrated description of the "*Holderness*" *Bevel-edged File* which is a millsaw file with the edges three-sided instead of semi-circular. Users say that the new shape is a great improvement and lasts at least twice as long as the old. This appears to be due to the fact that it is impossible to cut the file teeth of even depth on a sharply curved surface, and therefore the whole file is rejected as soon as the round edges are worn and long before the flat sides are worn out.

*

New Tyre for Heavy Motor Vehicles.

THE Palmer Tyre, Ltd., send us a letter in which they state they are introducing a pneumatic tyre to carry a wheel-load of 3 tons It is built of patent "airless cord" and the best Para rubber. It is further stated that "airless cord" can be built to almost any strength without affecting the resiliency.

*

The "Thikflex" Cord Grip Lampholder.

MESSRS. BAXENDALE AND Co., of Manchester, have sent us a sample of their new patent "Thikflex" Cord Grip Electric Lampholder, which we have tested and found to be a great improvement in every way upon the ordinary lampholder. It has fewer parts. and these are larger and stronger, though the holder itself is no bigger.

The case is in only two parts, which screw together and interlock the cord grip, china interior and terminals with each other so that it is impossible for them to be twisted or become detached. The interior, which is in two parts, is of best English china, and is so constructed that when put together the terminals, which are not permanently fixed to the china, are held quite firmly in position, and are entirely insulated from one another and from the case itself, no metal being exposed beyond the plungers themselves. The terminals, being loose, are much more easily wired. The cord grips are very effective, and cannot be twisted. It gives such a firm grip on the flexible that all strain is taken off the connections.

It is a very substantial fitting, and very suitable for use in factories, workshops, &c.

*

Asbestos Sheathed Fuse.

MESSRS. JOHN FOWLER AND Co., LTD., of Leeds, have sent us a sample of Hall and Fuller's patent asbestos-sheathed fuse which they make.

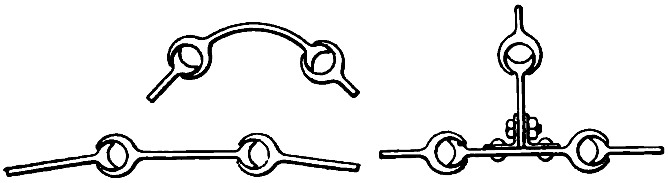
The fuse consists of a special arc-damping sheathing, through which bare fuse wires have been drawn. With this arrangement the circuit is effectually broken, and the formation of an arc prevented, either with a slow or rapid increase of current. The sample length sent us consists of 10 wires sheathed with asbestos, and fuses at about 80 amperes. A less fusing current is secured by withdrawing one or more wires to suit; while for a greater current one or more sheathed fuses are used in parallel.

*

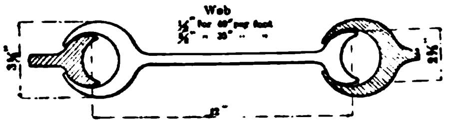
Steel Sheet Piling.

THE United States Steel Sheet Piling Co., 135, Adams Street, Chicago, has brought out a new type of interlocking sheet steel piling. It is a rolled section of entirely new design, consisting of a flat web with circular grooved flanges, as shown in the accompanying illustrations. There are no bolts, rivets, or other attachments, and it is ready for use as it comes from the mill for all purposes for which sheet piling can be used. By packing the grooves with mud, clay, or other suitable material, the cofferdam

can be made water-tight. The cylindrical tongue and groove give lateral strength and permit of a noteworthy range of flexibility in the use of the piling, as corners are readily turned, and the direction can be changed at any point, without using special



Various Adjustments of Steel Sheet Piling.



End View of Steel Sheet Piling.

sections. Each pile is complete in itself and is interchangeable. It is rolled in sections weighing 35 and 40 lbs. per ft., and in lengths as required. It is first rolled as an I-beam shape, the circular flanges being formed by a second process.—*Railway and Engineering Review.*

*

Granting Facilities for the Construction of Light Railways.

AMONG the mass of inane and vapid "conclusions" arrived at by the recent International Railway Congress there are a few—very few—which are worth very careful consideration. One of these refers to the construction of light railways, and reads as follows:—

Light railways merit in the highest degree the attention of public authorities. Their construction makes it possible to encourage the progress and development of districts which previously have remained in the background, and it is accordingly not only the interest but the duty of the Governments to assist them. It is desirable, therefore, not to adhere to old types and old methods of construction, operation and regulation, but to introduce every facility possible, adaptable to local needs and available resources. It is also desirable that State Governments and local authorities should accord to light railways, either under the form of subsidies, relaxation of requirements or other methods of assistance, the support which they need, both for construction and for operation, so that all parts of the country may be adequately served. When the authorities of a country do not themselves construct or work light railways, but turn them over to private companies, it is indispensable that the terms of the concession should be so defined as to harmonise the interests of the working company with those of the public.

The above resolution, of course, pre-supposes that the Government and local authorities are reasonable bodies to deal with. But this country is blessed with a Board of Trade, which is quite grandmotherly in its unreasonable attitude towards the construction of light railways, and also with corporations and county and urban councils which, when not acting the dog-in-the manger, fasten on to promoters such onerous, not to say blackmailing, conditions that it becomes impossible to raise the necessary capital, and if by these means they succeed in killing the scheme they plume themselves on having accomplished a meritorious feat—"in the interests of the ratepayers," of course.

*

The Phœnix Tender Spring.

A NEW design of elliptic tender spring, which incorporates a new scheme of end fastening, has recently been placed on the market by the Phœnix Car Spring Co., of Chicago. This spring consists in providing end plates and connections, arranged between the upper and lower halves of the spring, forming a convenient mode of connection, so that the springs are easily assembled and disassembled. The weakening of the main plates adjacent to their points of connection is overcome and the risk of breaking lessened. Heretofore, the upper and lower halves of elliptic springs have commonly been formed with scrolls or eyes at their ends connected by a bolt with a curve or neck, in the main leaves adjacent to the scroll. This neck has proved to be a weak point, and the main leaf could not be reinforced at that point because if the second leaf or leaves were elongated for that purpose they would slide on the main leaf when used and strike the projected curve of the eye. In this design the ends of the halves are connected by malleable rockers, shown in detail on the illustration, which retain the spring in proper relative position. Their longitudinal end pockets and centre flanges confine the ends in alignment, preventing them from twisting out of true, and the plates then move easily as the springs are elongated or contracted by changes

in the load and afford a bed for the ends of the halves. With no load, or with light load, the weight is supported on the extreme ends of the spring, and as the load increases the springs are compressed and shortened on the bed of the rocker castings, thereby increasing the capacity and resistance in proportion to the load. Another feature of this design which should be noticed is the ease and economy with which a section can be removed in case a leaf breaks, and be replaced by a new section from a standard stock. The illustration shows a double elliptical spring, but the same principle can be used with any number of sections. This type of tender spring is guaranteed by the manufacturers for two years' service.—*Railway and Engineering Review.*

Books, Papers, and Pamphlets Received.

Graphic Statics, 26 graduated exercises in. Some in two colours, and with skeleton data to practise upon, and including the application to roofs, moving locomotives, retaining walls, Lévy's steel arches, girders (original constructions), masonry arches and Lévy's weight tables; with an essay on graphical statics in the form of a running commentary on the exercises, each of which has full instructions printed on its face; the whole forming a supplement to the author's "Elementary Applied Mechanics." By T. ALEXANDER, M.Inst.C.E.I., Professor of Engineering, Trinity College, Dublin, and A. W. Thomson, D.Sc., C.E., Professor of Engineering, College of Science, Poona. London: Macmillan and Co., Ltd. 1905. [36 pp.; 14¾ins. x 18¾ins.; price, 10s.]

The Flow of Water through Pipes—Experiments on Steam-line Motion and the Measurement of Critical Velocity. By H. T. BARNES, D.Sc., and E. G. COKER, M.A., D.Sc. From the Proceedings of the Royal Society, Vol. 74.

A Laboratory Apparatus for Measuring the Lateral Strains in Tension and Compression Members, with some Applications to the Measurement of the Elastic Constants of Metals. By E. G. COKER, M.A., D.Sc., F.R.S.E. From the Proceedings of the Royal Society of Edinburgh, 1904-5. Edinburgh: Robt. Grant and Son, 107, Princes Street. 1905. [Price 6*d.*]

British Standard Specifications. No. 13 *for Structural Steel for Shipbuilding.*
No. 20 *for Screw Threads.*
No. 21 *for Pipe Threads for Iron or Steel Pipes and Tubes.*
Reports issued by the Engineering Standards Committee, Leslie S, Robertson, M.Inst.C.E., secretary. London: Crosby, Lockwood and Son, 7, Stationers' Hall Court, E.C. December, 1904. [Price 2*s.* 6*d. net* each.]

"*Red Books*" *of the British Fire Prevention Committee.* Edited by the Executive. London: Published at the Offices of the Committee, 1, Waterloo Place, Pall Mall. [Price 2*s.* 6*d.* each.]

The Committee's Reports on Fire Tests:—
No. 91. *Electro Glazed Casements* by the British Luxfer Prism Syndicate, Ltd., London.
No. 92 and 93. *Partitions* formed with Mantada Slabs fixed by the Adamant Co., Ltd., London and Birmingham.
No. 94. *An Automatic Fire Alarm System* by the Autopyrophone Co., Ltd., Copenhagen.

Great Eastern Railway Co.'s Tourist Guide to the Continent. Edited by PERCY LINDLEY. Illustrated. London: 30, Fleet Street, E.C. New York: 362, Broadway. [Price 6*d.*]

Compound (4-Cylinders) Express Engines "Adriatic" Type; Southern Railways of Italy.*

BY CHARLES R. KING.

THE most striking feature of these engines is that the boiler is reversed, the firebox being over the leading bogie. The first engine was designed under the superintendence of Signor Plancher, and built at the works of the *Strade Ferrate Meridionali, Rete Adriatica* (Southern Railways, Adriatic System), at Florence. In 1902 sixteen others, with alterations in the details, were built by E. Breda and Co., Milan, and Borsig, Berlin, to the annexed drawings. The chief dimensions are:—

Cylinders.
Two high pressure on right-hand side, diam. 14ins.
Two low pressure on left-hand side, diam. 23·2ins.
Stroke of pistons, 25·5ins.
Volume of clearance per cent. of stroke volume—
high pressure, 15 per cent.
low pressure, 8 per cent.
Piston valves, h.p. and l.p., diam. 10·4ins.
Smith's patent valve rings.
Steam lap of valves, h.p. and l.p., 1·338in. and 0·905in.
Negative lap and exhaust lead h.p. and l.p., 0·0787in. and 0·1181in.

Wheels.—Diam. 6ft. 3⅝ins., six coupled.
Tractive Effort.—6½ tons.

Boiler.
Working pressure, 213 lbs. per sq. in.
Diam. inside, greatest 4ft. 8¼ins.
Height of centre line above rails, 8ft. 8½ins.
Tubes, brass, 125 Serve, 4 plain, diam. 2¾ins. by 13ft. 2ins. long.
Heating surface, tubes 2,130 sq. ft.; firebox 124 sq. ft.; total 2,254 sq. ft.
Grate area, 32·3 sq. ft.

Weight of Engine.
Empty, 61½ metric tons; full, 70½ metric tons; on the coupled wheels, maximum 43·8 tons; on leading bogie, 26·7 tons (coal bunker holds 4 tons).
Maximum axle-load allowed 14·6 tons.
Weight of cylindrical water tank, 16 tons; water capacity, 106 cub. ft.
Total (max.) weight of engine and tender, 106·5 metric tons.
Total length of engine and tender, 82ft. 6ins.

The engines, illustrated by the annexed drawings are a modification of the type-engine "5001" exhibited at Paris in 1900, and which was, itself, altered when the 16 engines were built to this design in 1902.

The unparalleled economy of the type induced the Italian Government—now in nominal possession of the State Railways of Italy—to order another lot of 14 engines, most of which have been delivered during the present year.

In these last engines the arrangement of the motion is the same as before, but the boiler is of another type having a sloping head to the wide firebox by which the boiler has been, in one way, reduced in weight, although the length of the grate has been slightly increased. At the firehole the inner and outer boxes have been flanged and rivetted together according to the Webb plan. The double-ported semi-relieved regulator-valve has been replaced by an entirely new type of cylindrical regulator valve having a three-phase movement in which the drop-seat valve has been introduced but without its notable defects. The blast pipe is made similar in action to those of the annular type, it now having a central core prolongation, 4¾ins. diameter, reaching to the chimney-top.

The cylinders, valves, and valve-motion remain precisely as shown on the drawings, except that the large low-pressure cylinder pistons are fitted with tail rods to relieve the weight of the pistons. Oblique-type, hollow, crank-axles are now used. The arm between the two crank-cheeks is of rectangular section, and the crank webs, 90° one in advance of the other, are of lozenge-shape, heavily-hooped. The cranks of each h.p. or l.p. pump stand at 180°.

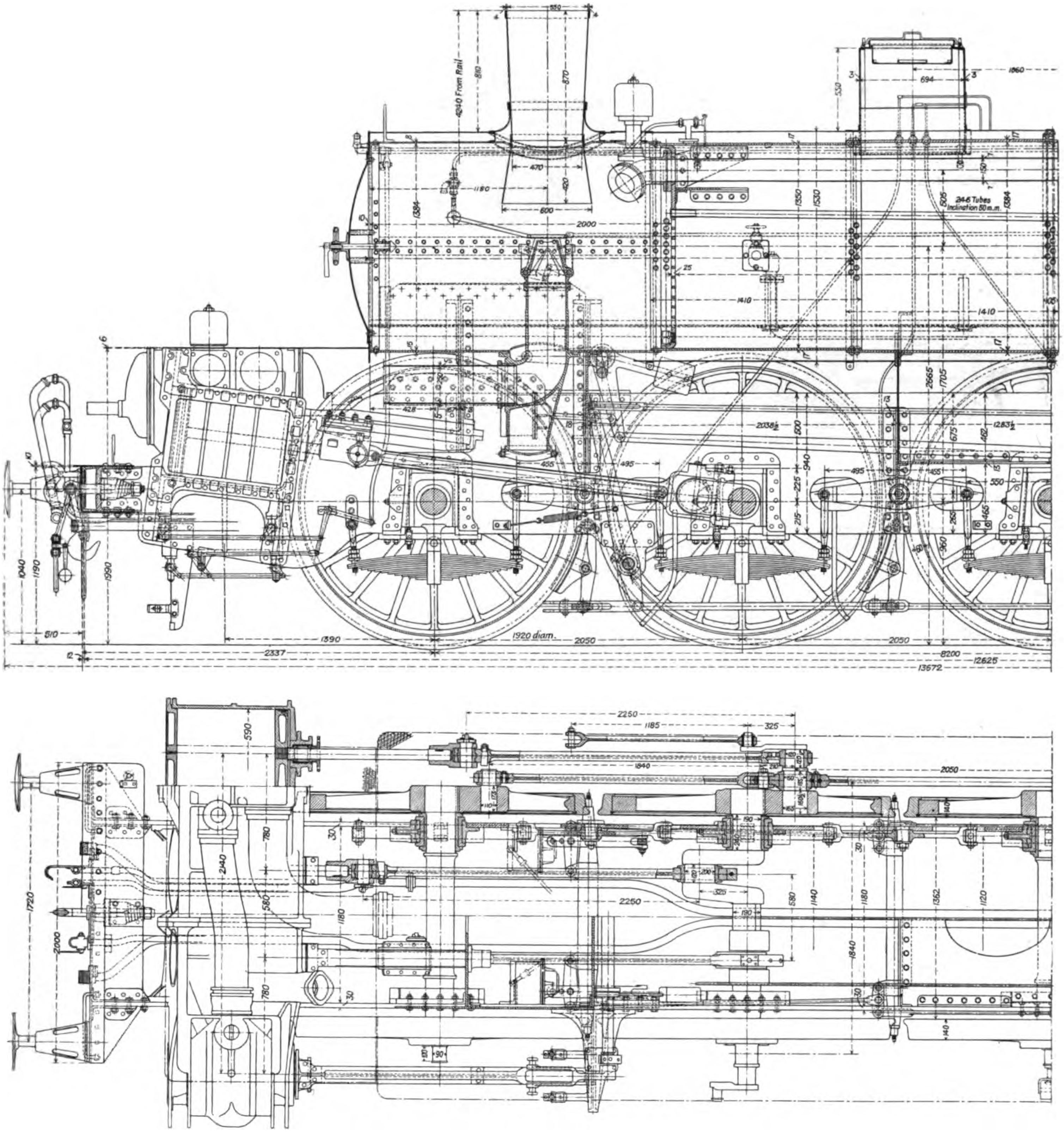
All the driving axle-boxes are now spherical, so that the engine frames may tilt out of vertical (as when on a curve, for instance), without unduly straining the guides, frames or journals. These spherical boxes (Zara's) were applied to some of the engines that are shown in the accompanying drawings.

It will be noted that the bogie is of the swing type without any lateral rigid supports for the engine frames, and without any controlling springs to the cradle; but in the engines just put into service helical springs have been introduced to limit the swaying of the bolster. The engine, however, remains one of the most flexible existing, regarded solely as a carriage, and is correspondingly easy on the light Italian permanent way.

The cab has been completely modified. It is now as roomy as a very large railway-carriage compartment, and with only one doorway—situated no longer in front, but on the left-hand or driver's side. The whole of the right-hand side is occupied by the coal-bunker, which reaches to the roof, and is, in fact, filled from a trap in the roof over the boiler. The side bunkers have been shortened as a consequence of the increased height, and the general appearance of the engine is thus improved. The result is that the fireman, without ever changing position, has little more to do than to slide the coal into the fire-box; and through the large bay windows in front he can, likewise without shifting his position and with less fatigue, keep a better look-out for signals than is possible upon any other form of railway locomotive existing. The ventilation of the cab has been improved by the addition of an adjustable roof vane.

These alterations of detail, although improvements of interest to the maintenance departments and to the enginemen, leave the engine unchanged as regards its power. The limit of weight per axle forbids the introduction of a larger boiler at present until heavier rails have been laid. This might be effected, even without awaiting reinforcement of the tracks, by the addition of a pair of trailing wheels, but such an arrangement would introduce that pivotal oscillation which this type of engine has the merit of avoiding.

* For external views of these engines and a full account of their performance see "Economical Locomotives," pp. 122-4 of the *Railway Engineer* for April, 1904.

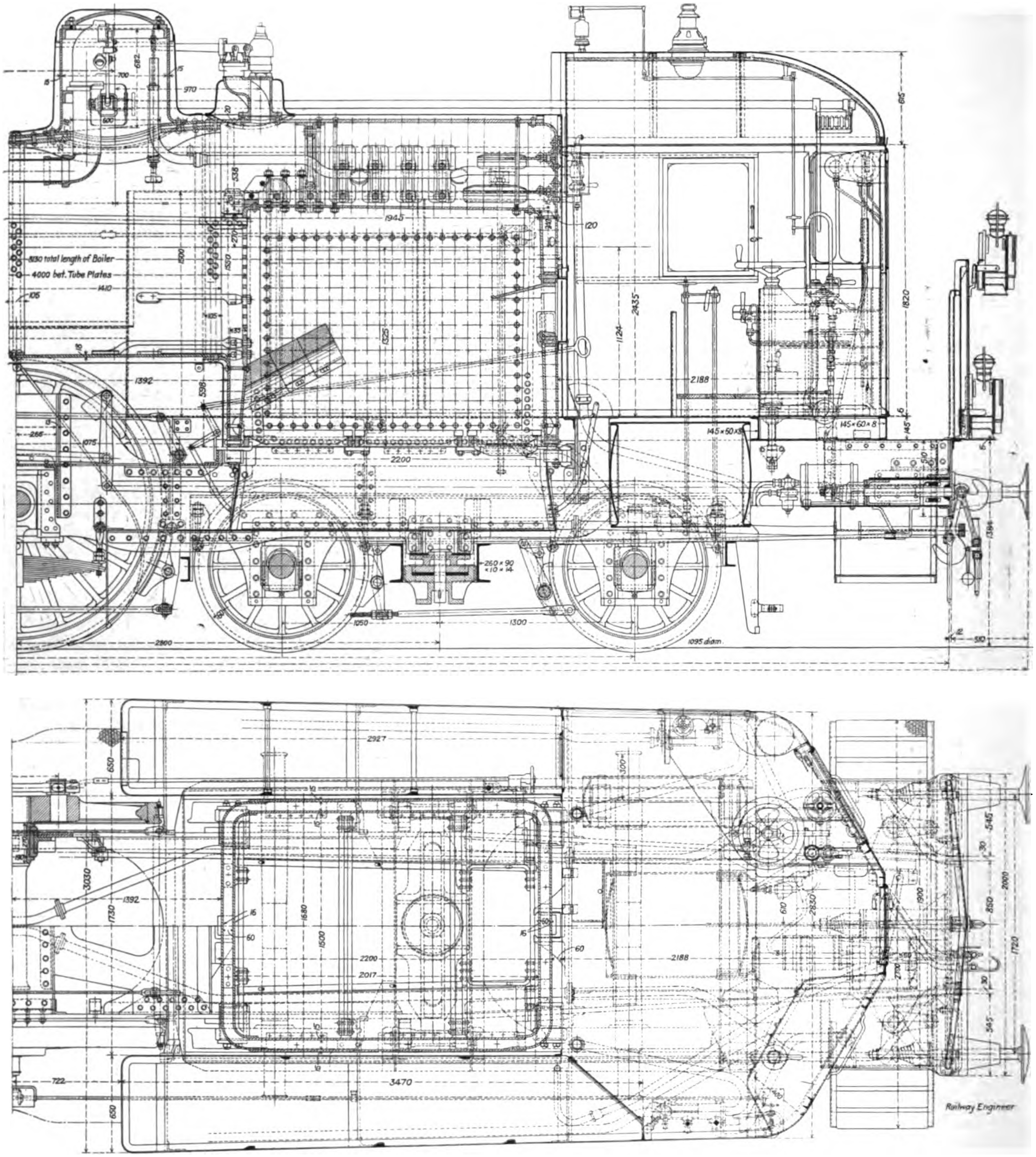


Compound (4-Cylinders) Express Engine

The primary object of reversing the boiler was to enable a deep and wide fire-box to be used and also a large ash-pan, and also without in any way being limited by the constructional gauge as would have been the case had it been attempted to place a wide fire-box right over the driving wheels—as is usually done with six-coupled express engines. As a direct consequence the cab was arranged in front.

The chief peculiarity of the cylinder grouping (both the h.p. to one side and both the l.p. to the other) enabled two piston-valves to distribute to four cylinders, while preserving the advantage of being able to set each valve for a different given degree of cut-off, in accordance with the most advanced modern locomotive practice in a steam distribution.

The elimination of two piston-valves is a saving of power, while variation of the valve travel for each group is attained just as in the most recent French engines (the p.l.m.), on which four



"Adriatic" Type; Southern Railways of Italy.

piston-valves and four distinct valve mechanisms are employed. The casting of the cylinders, with crossed steam passages in the high pressure group, presents no difficulty after the details of the work have been acquired, and out of 28 groups of high-pressure and low-pressure cylinders cast recently only one was found defective.

All four cylinders, the two outer horizontal and the two inner inclined, are now ream-bored simultaneously upon a machine built by Breda and Co., Milan, and in this way a more perfect result is obtained than when groups of two cylinders are machined separately. To see if the castings be perfect they are first rough-bored upon an ordinary American machine.

All the locomotives of this type built this year were constructed by Breda and Co., Milan, for after a long trial of Italian and German built engines the former were found to give better results.

The Condition and Defects of Early Wrought Iron Bridges.

An examination of wrought-iron bridges built in the earlier days of railways, besides revealing the weakness general to girders which have to carry heavier loads than those for which they were designed, often brings to light local weakness, the result either of corrosion or unsatisfactory design. Corrosion is especially prevalent in districts subject to fumes from chemical or other works, and again in bridges which cross over a railway, the girders of which are thus subjected to the action of fumes from passing or standing engines.

Careful painting or coating with other protective covering will accomplish a good deal, but much depends on the selection of a paint suitable to the locality; a paint which affords efficient protection in one district will often prove unsatisfactory in another.

Bridges consisting of light lattice girders such as station footbridges are particularly liable to corrosion. In the first place there is the liability of engines standing under them, and smoke-boards offer only partial protection. The girders, too, being made up of a large number of bars and angles of light section, offer a comparatively large surface to corrosion.

Examinations show that wrought-iron is attacked more at the edges than on the surface of a plate or bar. This may be partly due to the liability of the paint to peel at the edges, but more probably to the nature of the material.

This is illustrated by the curious effect of corrosion upon the stiffening tees on the webs of some girders, which, being boxed in at the top, held the smoke from passing engines for a considerable time.

The stalk of the tee iron had swollen to an obvious extent, and with a chisel and hammer could be split into lamina with scarcely any effort.

Another frequent cause of corrosion is a floor which allows water to trickle through and lodge on the flanges of the girders. Timber floors generally possess this defect, and even with plate floors, a bolt hole with the bolt missing or the nut loose may be sufficient to cause excessive stress locally as the result of the wasting of the material by corrosion.

The webs of old wrought-iron girders, seldom very substantial at the best of times, are very frequently found weakened by corrosion, and until the rust eats right through and leaves a hole, or the web buckles as the result of excessive stress, the damage is often unsuspected. Water coming through the floor generally runs down the web, leaving it wet and just in the state for water and oxygen combined to attack the iron.

The water after running down the web settles on the surface of the bottom flange in a pool, and only at the edge of the pool can the two agents necessary to produce corrosion meet. This may be an additional reason why the edges of the flange plates are more excessively corroded than the surfaces.

Excessive corrosion must always be a source of uncertainty in arriving at the strength of a girder affected by it on account of the difficulty in ascertaining the area of the section remaining sound. It is possible, too, that corrosion may have an effect upon the resistance of the metal remaining.

Chief among the defects due to bad design are joints in plates and angles not properly covered, and in some cases it is a little difficult to determine the precise strength of a group of joints in the plates composing the flange.

Many of the older girders have been built with a packing strip between the angles and the flange plates, which strip is replaced by a cover the full width of the plate where joints occur. In such cases, as there is often a second cover on the outside of the plates, the rivets are in double shear, and the strength of the joint covered in this way is generally ample.

If the covers do not occur at or near the centre of the span, the area of the strip can be counted, in calculating the area of the section throughout which the maximum flange stress is divided, but when this is done it is necessary to investigate whether the maximum intensity of stress occurs at the centre or at the joint in the packing strip nearest to the centre.

In cases where the flange is composed of two plates it is not unusual to find joints in the inner plate covered by a single plate between the angles and the flange, and the joint in the outer plate covered by an external cover plate only. A modification of this arrangement, with the omission of the packing strip, is also found, and in this case the joints in the inner plate are only covered by two strips, one on each side of the angles, the combined area of which is considerably less than that of the plate. Such joints as these are a frequent source of weakness to girders in which they occur.

The covers to joints in angles are frequently deficient both as regards the area of the angle cover and the number of rivets. The tables of the angle cover are of necessity less than those of the main angles, and unless the thickness is proportionately increased the area is of course less. In girders where the packing strip occurs the latter will make up for such deficiencies in the angle cover. It is a very generally accepted rule that a joint is satisfactorily covered when the rivet area resisting shear is at least equal to the area of the plate resisting tension. If there is one cover to two or more joints in different plates, the precise strength of each joint is not always easy to determine. If the plates are of the same section and the joints divide the cover into bays, through each of which an equal number of rivets pass, the area of this number of rivets can be compared with the area of the plate as in a single joint. If, however, the plates are of different thicknesses, or if the number of rivets between pairs of joints varies, a correct idea of the efficiency of the cover can only be obtained by examining the strength of the arrangement as a whole.

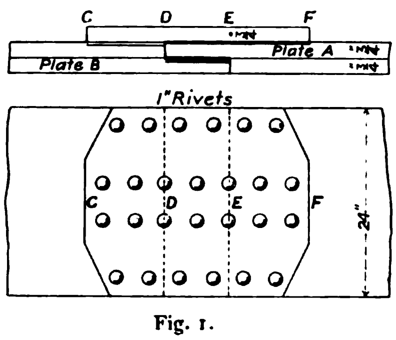


Fig. 1.

For instance, the joint sketched in fig. 1 may fail in four different ways, and each of these should be examined to see which offers the least resistance.

(1). If the plate B fail at D and the rivets between D and C shear, the area of the plate B and the area of the rivets between C and D must be compared with the area of the two plates.

Area of plates resisting tension = 2 × 24 ins. × ¾ in. -- four 1⅛ in. holes = 29·25 sq. ins.

Area of plate B = 29·25 ÷ 2 = 14·62 plus rivet area between C and D = 8 × ·785 = 6·28 = 20·9 sq. ins., or a deficiency of 8·35 sq. ins.

(2). Considering the plate A to fail at E and the rivets between E and F to shear, there is in this case the same deficiency as in 1.

(3). If the rivets along the thick lines shear the total rivet area is 16 × ·785 + 6 × ·785 = 17·27 sq. ins. And the deficiency is 29·25—17·27, say 12 sq. ins.

(4). If the rivets along the double lines shear the total rivet area is 16 × ·785 = 12·56 sq ins., and this, the greatest deficiency, is 16·7 sq. ins.

Some of the older wrought-iron girders have top flanges of cast iron, and, although the material itself is well suited to resist compression, a source of weakness exists in the connection of such flanges to the wrought-iron web plates. Some are bolted and others are riveted, and when the latter is the case cracks are often found. These are probably caused at the time of riveting, but possibly in some cases they are the result of excessive stress occasioned by the load on the girder.

Fig. 2 illustrates an example of such a crack, which was not a solitary case, but occurred at several similar places in the girders composing the bridge from which the example is taken.

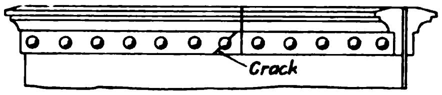


Fig. 2.

The top flange was in lengths butting, but not connected together except through the web, and the cracks were probably caused by excessive bearing of the rivet on the casting as the result of the two castings not butting well together.

It is very rare in old girders to find anything beyond the stiffeners to indicate the presence of joints in the web plate, and even in modern practice it is very usual to consider an ordinary tee stiffener a sufficient cover to a web joint. Doubtless in many cases such a cover is sufficient to resist the shear, especially at the centre where this is least.

It is a very useful rule to reckon the flange as taking the stress due to the bending moment, and the web as resisting the shear, for purposes of calculation, but it should not be forgotten that a web plate with properly covered joints is capable of resisting the bending moment due to an appreciable proportion of the load, which may be averaged at 10 % of the total.

It is quite worth while to expend a small amount of material in proper covers to the web in order to obtain this useful reserve of strength, for which a future generation of railway engineers, who will perhaps have to deal with even heavier rolling stock than that in use at the present day, may be very thankful.

For instance, in a large girder an outer strip of the web of the same width as the flange is not much nearer the neutral axis than the flange itself, and therefore will be nearly as severely strained. If the joints are as adequately covered as those in the flange it will sustain this stress and relieve the flange of a proportionate amount. Even as regards the stress due to shear, the webs of some old girders are weak and occasionally give way by buckling, especially where cross girders are connected to them, and introduce a tendency to bend the web.

The cross girders in old railway bridges are frequently inadequate for modern locomotives, and very generally strengthening has been necessary either by the addition of distributing beams or girders, or extra cross girders, or by the substitution of an entirely new floor. In cases where additional cross girders have been put in between the existing ones it has often been necessary to insert the new girders in two pieces and join them together when in position. When this is done great care is necessary to ensure the new girders taking a sensible portion of the load. Tests of the deflection of the old girders before and after offer the most satisfactory evidence as to whether they have been relieved sufficiently of the load they were originally carrying.

The safe limit of stress for wrought-iron bridges is a figure open to question. The usual working stress is 5 tons per sq. in., or just about a quarter of the average breaking stress.

The working stress for mild steel is generally taken at 6·5 tons per sq. in. Beyond the elastic limit the material as strained in the girders of a bridge is not comparable with the test piece in the testing machine, and although the breaking stresses of mild steel and wrought-iron are roughly in the proportion of 3 to 2 the stresses at the elastic limits are far more nearly equal. In fact, in some tests which came under the writer's notice the stress at the elastic limit was higher for the wrought-iron than for the steel specimens.

For the former the average breaking stress was 21 tons per sq. in., the stress at the elastic limit 16·6 tons per sq. in., and the average elongation in an 8-in. length 8·2 %

For the mild steel specimens the average breaking stress was 25·6 tons per sq. in., the average stress at the elastic limit 14·3 tons per sq. in., and the elongation in the same gauge length averaged 29·9 %.

It might therefore be inferred that wrought-iron might safely be strained to as high a stress as mild steel, if it were not for the fact that wrought-iron is not such a reliable material as steel.

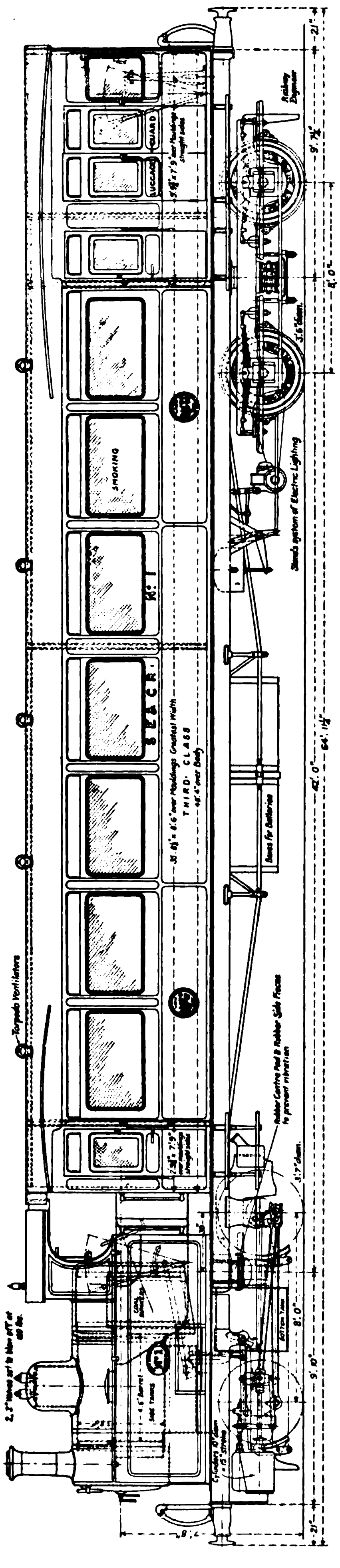
The late Sir William Fairbairn, in an appendix to his book entitled "Useful Information for Engineers," gives the results of some tests conducted by him in 1838 upon wrought-iron plates and riveted joints, in connection with an enquiry into the use of iron plates for ship-building. These results, which indicate the nature of the material used in the early days of wrought-iron plate work, are very interesting. There is no indication given of the ductility of the specimens in the form of measurements of elongation, but the dimensions of the reduced section at fracture are given, and from these the percentage contraction of area can be calculated. This figure, however, is not very constant.

The mean breaking stresses of different varieties of iron are given as follows :—

Yorkshire plates,	0·22 ins. thick,	25·77	tons per sq. in.
,, ,,	0·26 ,, ,,	22·76	,, ,, ,, ,,
Derbyshire ,,	0·22 ,, ,,	21·68	,, ,, ,, ,,
Shropshire ,,	0·22 ,, ,,	22·83	,, ,, ,, ,,
Staffordshire ,,	0·22 ,, ,,	19·56	,, ,, ,, ,,
	Mean	22·52	,, ,, ,, ,,

In looking at this result it is necessary to note that the test pieces are somewhat thin, and to remember that modern experiments invariably indicate a higher breaking stress for thin than for thicker plates.

The percentage contraction of area of the specimens of Yorkshire plates 0·22 in. thick was fairly constant, the mean being 20 %, but for the same plates 0·26 in. thick the contraction of area was only 10 %.



Steam Motor Carriage; South-Eastern & Chatham Railway.

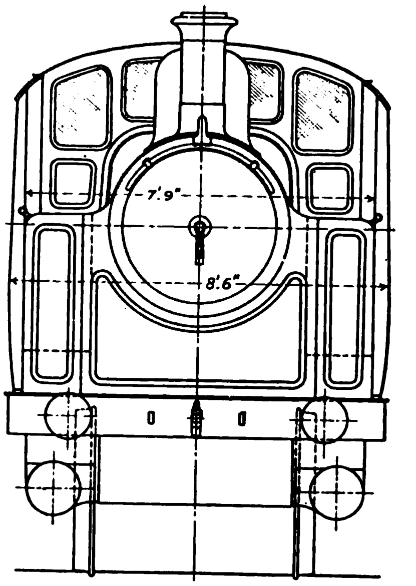
The experiments on the strength of riveted joints indicate that the proper proportion of rivets is obtained when the area to be sheared is equal to the net area of the plate resisting tension.

Comparing the strength of the ordinary test bars with those consisting of two plates riveted together, the results show that it is not necessary in obtaining the net area of the plate to deduct holes of larger diameter than that of the rivets themselves. It would seem, therefore, that any damage done to the material in punching was compensated for by the increased strength of a bar in which there are notches or holes to hinder local contraction. It must be added that the plates were only 0·22 ins. thick, and thicker plates would be more likely to sustain injury from punching than such thin ones.

The writer has not heard of any tests being made upon specimens of wrought-iron taken from old girders, but judging from the results of tests made upon strips cut from boiler plates which had been in use since 1859, it does not seem that wrought-iron at that time was of the quality, especially as regards ductility, that would be required at the present day. This is also indicated by the variation in the contraction of area in Sir W. Fairbairn's tests previously referred to.

Steam Motor Carriages; South-Eastern and Chatham Railway.

In our Marsh issue we published an illustrated description of the new Steam Motor Carriages which Mr. Harry S. Wainwright, M.Inst.C.E., the chief mechanical engineer of the S.E. and C.R., has designed for service upon the Sheppey and other sections of his Company's system, and we are now able, by his courtesy, to produce an outline drawing which gives a better idea of the construction of these vehicles, which were built by Messrs. Kitson and Co., Ltd., Leeds, and the Amalgamated Railway Carriage and Wagon Co., Ltd., Birmingham, than the external view in our March issue.



It will be seen that the carriage is independent of the engine, except that one end of it is supported on a centre carried on the engine frames.

The boiler is of the locomotive type, having a barrel of 3ft. 8ins. diam. by 4ft. 6ins. long, with its centre line 7ft. 8ins. above the rail. It contains 167 tubes 1⅝in. diam. It has 381·5 sq. ft. of heating surface, of which the tubes provide 337 sq. ft., and the fire-box 44·5 sq. ft. The grate area is 8·8 sq. ft. The working pressure 160 lbs. per sq. inch. The water capacity is 400 gallons and the coal capacity 15 cwts. Two "pop" safety valves 2ins. diam. are fitted.

The cylinders are outside 10ins. diam. by 15ins. stroke; the engine wheels, which are 3ft. 7ins. diam., are coupled; the valves are on the top of the cylinders and are operated by the Walschaërt gear.

The carriage body is divided into three compartments, viz., for non-smokers, 32 seats, 19ft. 10⅝ins. long inside; for smokers, 24 seats, 14ft. 10⅜ins. long inside; and for the guard, luggage, etc., 6ft. 8ins. inside.

The vehicle can be controlled or operated from either end. It is provided with large side windows and is fitted with electric light. It is well ventilated by means of torpedo air extractors. Particular care has been taken to prevent vibration by cushioning the body on rubber pads.

The wheel base of both the bogies is 8ft.

The O.M. Edwards Balanced Carriage Window.

The annexed drawing illustrates the arrangement of the O.M. Edwards Co.'s patent balanced window which is suit able for saloon and other railway carriages.

It will be noticed that the balancing mechanism is more particularly intended for large drop-lights, and consists of a spring roller placed between the pillars as high as possible above the light, and which, by the tension of the spring it encloses, winds up a broad linen band *a*, which is

attached to the top rail of the drop-light, *b*, when the thumb-catch *l* is worked. The winding up of the band raises the window, but upon the thumb-catch being released the movement of the window is arrested and the light wedged tightly against the frame. The amount of tension on the spring is adjusted by means of a light portable key which operates the worm wheel at *c*.

Fig. 2 shows a perspective view of the mechanism, and the method of adjusting it by means of standard gauges.

The window is operated from the sill by the finger pieces of the latch *l*, which are connected to flat bars *dd*, pivoted at *ee*, which engaging with small bell-cranks *f*, centred on the pin *g*, which is fixed to the bar *h* which is screwed to the pillar. The short arm of the bell-crank is connected to a light angle wedging bar *i*, this is coupled to the fixed bar *h* by inclined links *mm*. The wedging bars are normally thrown upwards and outwards by the spring *k*, thus forcing the window frame outwards against the outer run or moulding.

To open or raise the window the finger pieces of the latch are pressed together and the catch thereby withdrawn. This movement, also by means of the bars *dd*, releases the wedging bar *i*, and the spring roller automatically raises the window, but the upward movement is immediately arrested by releasing the finger pieces *ll*.

A number of these windows have been fitted on American cars, and also to some of the carriages built in this country for South American railways.

Further particulars may be obtained from the Pneumatic Engineering Appliances Co., Ltd., Palace Chambers, Westminster.

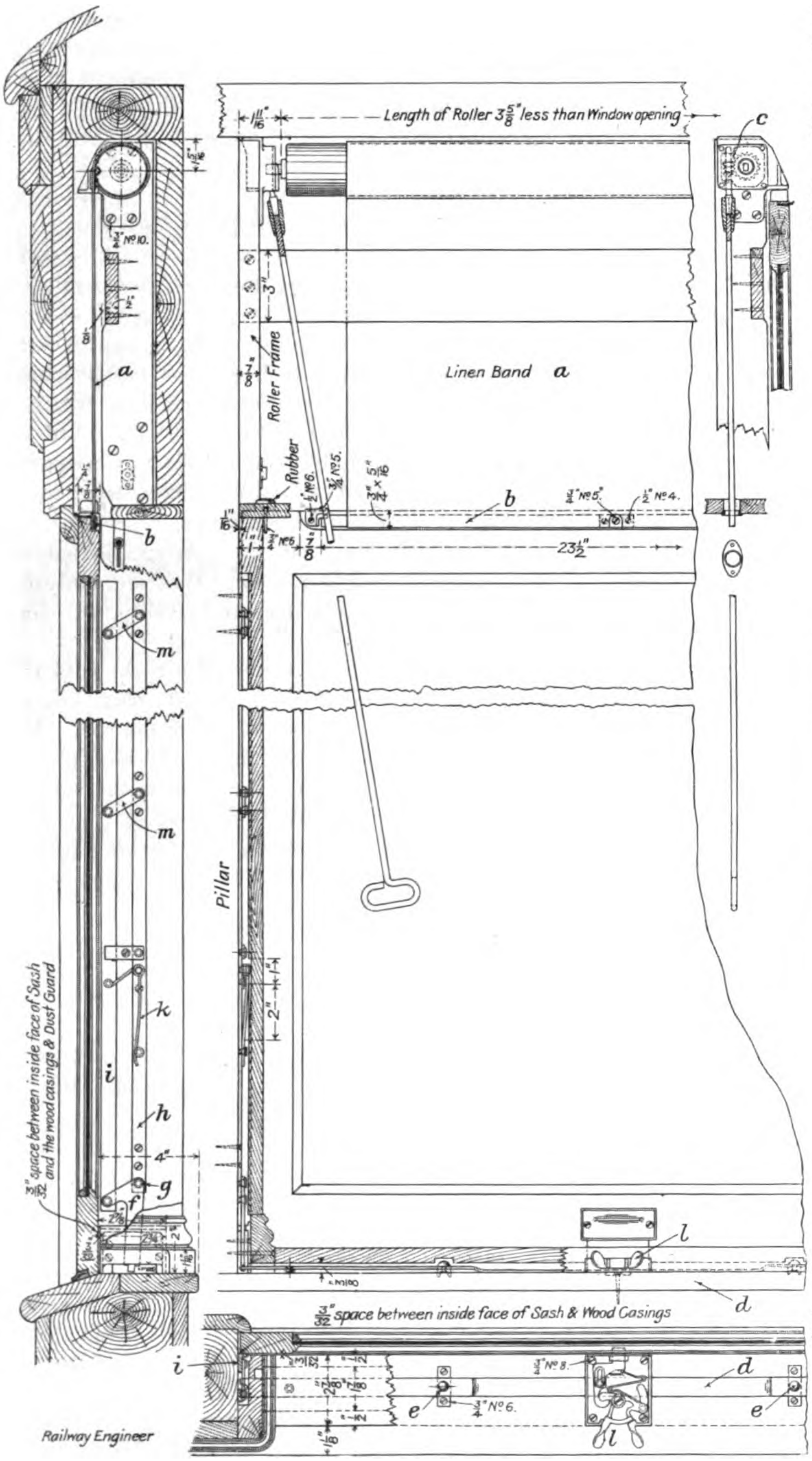


Fig. 1.

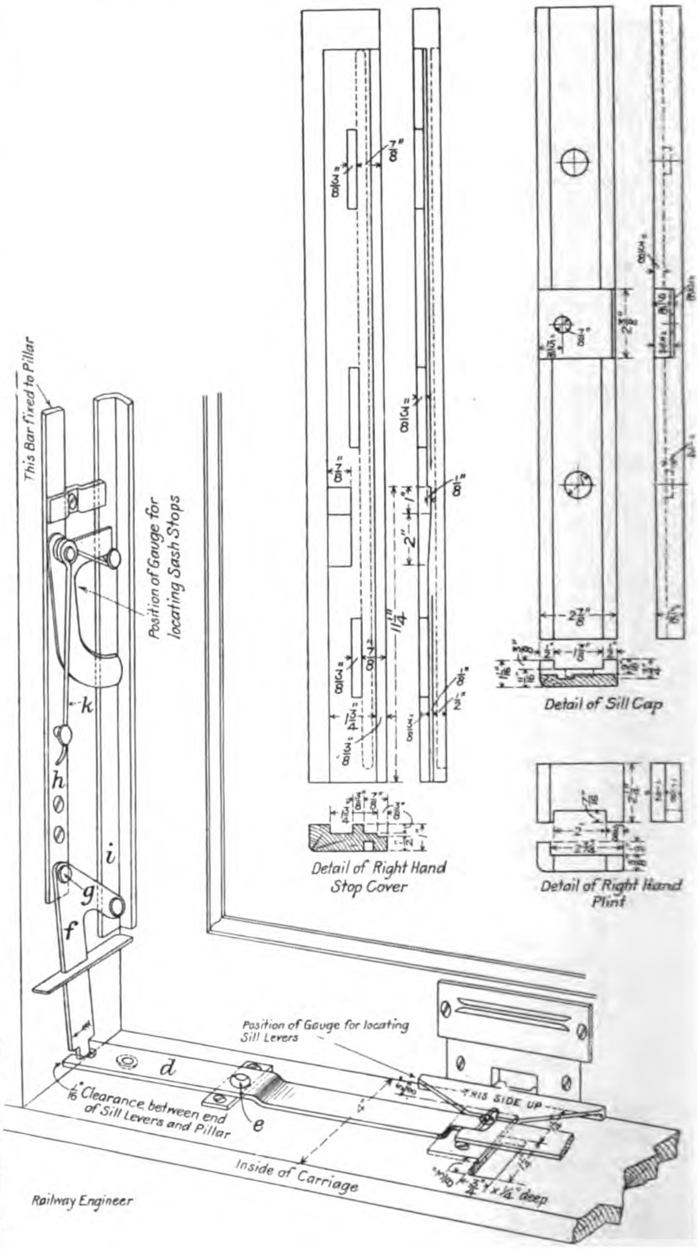


Fig. 2.

The O.M. Edwards Balanced Carriage Window.

Western Australian Government Railways, 1903-4.*

THE Commissioner of Railways, Mr. Wm. J. George, in his annual Report upon the working of the West Australian Government Railways during the year ended 30th June last, gives 1,755m. 5chs. as the total length of the lines open for traffic: of this mileage 213m. 58chns. are sidings. During the year 23½m. were opened for traffic.

The Upper Darling Range Branch was purchased at the rate of £1,000 per mile. The general condition of the line was extremely bad: banks and cuttings narrow, accommodation and water supply insufficient, and appliances for safe working almost entirely lacking. During the year over £8,000 was expended in work necessary to bring the line towards a proper standard of efficiency, and a further £6,000 will have to be spent on the line. The effect of opening this line has been to divert from the Eastern Railway and the Smith's Mill Branch traffic which could have been worked more profitably on those lines. The main traffic (timber) has practically ceased owing to the area being cut out, and the consequent closing of the Canning Jarrah saw mills.

It has been inadvisable to use the Collie-Collie Boulder Extension for through passenger traffic, owing to extensive undermining near Collie. Except for coal traffic, and a few local passengers, it is practically of little value for revenue purposes. An expenditure of, approximately, £1,000 is being undertaken to fill up the workings under the line in such a manner as to render the surface free from danger of subsidence. The coal traffic is unprofitable, as the Department is practically the sole customer of these mines, and all the coal required by the Department could have been obtained from mines at Collie, and so saved the expenditure and the cost of working.

The main particulars of the year's working and the differences as compared with the previous year's working are set out below:—

Total amount debited, cap. account	£8,955,929	+ £814,147
Average number of miles worked	1,535	+ 101
Cost per average mile worked ...	£5,834	+ £156
Amount debited for interest at 4 %	£296,676	+ £21,951
Gross earnings	£1,588,084	+ £34,599
Working expenses	£1,179,624	—£68,249
Surplus, earnings over wkg. exps.	£408,460	+ £102,848
Surplus, over wkg. exps. and int.	£111,784	+ £80,897
Perctage. of wkg. exps. to earnings	74·28	—6·05
Percentage of surplus to capital...	4·56	+ ·81
Earnings per average mile worked	£1,034	—£49
Working exes. per avg. mile wrkd.	£768	—£102
Net return per average mile wrkd.	£266	+ £53
Train miles run	4,594,234	—17,081
Earnings per train mile	82·96d.	+ 2·11d.
Working expenses per train mile...	61·62d.	—3·33d.
Net return per train mile	21·34d.	+ 5·44d.
Passenger journeys	10,225,976	+ 1,119,580
Paying goods tonnage	2,032,740	+ 259,103
Departml. gds. tnge. (non-paying)	224,494	+ 51,182
Live stock tonnage	24,530	+ 3,148
Total tonnage, gds. and live stk....	2,281,764	+ 313,433
Coaching revenue	£462,455	+ £25,223
Goods revenue (including live stk.)	£1,026,734	+ £42,857
Miscellaneous revenue	£98,895	—£33,481
Miles open 30th June (Main Line)	1,541	+ 25
Locomotives in traffic, 30th June...	329	+ 13
Passenger vehicles, 30th June ...	269	+ 5
Brake vans in traffic on 30th June	127	+ 14
Goods vehicles in traffic 30th June	5,632	+ 51
Do. equivalent in 4-wheel wagons	7,551	+ 63
Persons employed on 30th June...	6,747	+ 506
Avge. employed, exc. casual hands	5,616	—2

*For previous year's report see *Railway Engineer* for 1904.

The result of working for the past financial year has been most gratifying. It has resulted in the largest return of profit on record since the Government has owned railways, and there are some other striking features to which attention may be drawn. The increased average mileage worked throughout the year has been 101 miles. The earnings have increased £34,599 and the expenses have decreased £68,249, a total credit of £102,848. The tonnage figures, as well as the passenger journeys, show all round increases, which reflect the active condition of trade during the year.

The details of the expenditure, together with the percentage of revenue of each and the differences compared with the previous year's working, were:—

	£	£	%	%
Loco., carriage and wagon	547,868	—40,454	34·50	—3·37
Replacing obsolete rolling stock	33,787	—20,699	2·12	—1·39
Permanent way	236,089	+ 4,119	14·87	—0·06
Traffic and jetty	306,998	— 5,366	19·33	—0·78
Compensation	3,940	— 868	0·25	—0·06
Electrical (including telephones and light) ...	22,487	— 4,544	1·42	—0·32
Signalling and interlocking	5,854	— 693	0·37	—0·05
Generally	22,601	+ 256	1·42	—0·02
Total ...	1,179,624	—68,249	74·28	—6·05

The sources of the revenue were:—

	£	£
Passengers	398,067	+ 17,345
Parcels, horses, carriages, etc. ...	64,388	+ 7,878
Cloak room	2,691	— 83
Mails	19,340	+ 9,669
Goods and minerals	996,175	+ 42,744
Live stock	30,559	+ 113
Wharfage and jetty dues	40,215	—22,448
Rents	18,861	+ 3,694
Miscellaneous	17,788	—24,313
Total	1,588,084	+ 34,599

The decrease in working expenses is the result of careful economy in all branches, and also of the use on the heavy road, completed in 1902-1903, of the heavy type of locomotive introduced by the late Mr. T. F. Rotheram. Notwithstanding the increased average mileage in operation, and the increased volume of business in every direction, train mileage has been decreased 17,081 miles. To this fact the general decrease in all branches may be attributed. The decrease (£20,699) in rebuilding rolling stock is due to the completion, prior to 1st July, 1903, of an expenditure of £56,280 undertaken and spread over the years ending 30th June, 1902 and 1903, in equal proportions. This was incurred for the purpose of bringing up to standard 1,399 old and crippled wagons which required rebuilding or repairing beyond ordinary maintenance.

Revenue shows satisfactory increases under practically all headings. The decrease from wharfage (£22,448) is due to the fact of the Harbour Trust having controlled the wharves at Fremantle during the whole year, whereas in the previous year they controlled them only during the second half of the year. The decrease in miscellaneous items is due to an improved method of classifying revenue which has been adopted. It is worthy of note, for comparison with former

years, that expenditure has had to bear the following:—Extra pay to station-masters, officers in charge, and night officers. Extra pay under industrial agreement relating to traffic wages staff, and others of the ways and works, electrical, and interlocking branches. Overtime payments to loco. running staff under industrial agreement. The operation of the 8-hour day to practically all grades. Heavier maintenance charges on permanent way.

The revenue-producing goods traffic consisted mainly of "Other Minerals," such as bricks, road-metal, ballast, limestone, etc. (16·94% of the traffic); firewood (27·31%); locally grown timber (20·21%) and ores, slimes and tailings (9·04%).

All particulars in which the cost of working the several sections of the systems are omitted. The reason for this important change is that the only means by which such expenditure has been arrived at was on the basis of the expenditure per train mile; that is to say, if the total expenditure of the Department for the year, divided by the total train mileage run, showed a cost of (say) 5s. per train mile, and of that total train mileage 1,000,000 train miles had been run on (say) Eastern Goldfields R., then the cost of working the Eastern Goldfields R. was said to be £250,000. It appeared that to publish statements of sectional expenditure based on such a rough and ready method was entirely misleading for any purpose of accurately considering results. In the case taken for example—the Eastern Goldfields R.—no account was taken of the payment of the goldfields allowances to every employee east of Yerbillon, averaging £20 per man per annum, nor was any debit made for the extra cost of fuel and other stores by haulage to Kalgoorlie or other distant depôts, nor for the cost of water, which is extremely heavy on this section as compared with districts nearer the coast.

These charges, which are quite peculiar to this particular section, were merged into the whole expenditure, and, therefore, in the tables showing sectional expenditure, not only was the expenditure of this particular section shown as being lower than it should be, but the cost of other sections was really increased by reason of the average expenditure per train mile throughout all lines (including the peculiar items of expenditure above referred to) being taken as the basis of calculation of expenditure.

Locomotive coal mileage, which is treated as unproductive mileage and not included in train mileage, presents another phase of the question. The South-Western R., for instance, carries not only its own coal, but also coal for the Eastern and Eastern Goldfields R. as well, and the Eastern R. carries coal for the Eastern Goldfields R. as well as its own. But the debit made by taking the train mileage basis is exactly the same for coal used at Collie station as it is for coal used at Leonora.

Water trains are similarly treated as unproductive mileage, and are not included when the average expenditure per train mile is arrived at; consequently no debit is made for the haulage of water, of which, in effect, by far the largest portion is incurred between Kalgoorlie and Leonora.

The question of accurately arriving at sectional expenditure, in fact, bristles with difficulties, but one thing appears to stand out prominently, and that is that, so far as the railways of this State are concerned, the train mileage basis is unreliable and misleading for such a calculation.

The sectional earnings are not subject to the same difficulties as sectional expenditure, the calculation being a straight-out one, and the figures arrived at and published being quite reliable.

Private Owners' 20-Ton Tank Wagons.

In our issue for last February we published the standard specification for the construction of private owners' 10-ton tank wagons, settled by the Clearing House Committee of which Mr. James Holden, M. Inst.C.E. (locomotive, carriage and wagon superintendent of the Great Eastern R.), is chairman, and to whose courtesy we are also indebted for the specification of the private owners' 20-ton tank wagons from which abstracts are published below. Those parts of the two specifications which are common to both are omitted.

A list of the particular liquids which may be carried in these tank wagons will be found in the general railway classification of goods.

The specification is dated 1904.

The general regulations as to registration plates, inspection, testing, quality of material, &c., are the same as for ordinary private wagons, and which were published in our issue for October, 1903. The construction of the tanks may be varied by private owners under the same conditions that other private wagon bodies may be·

Principal Dimensions.

1.	The length of tank outside not to exceed ...	21ft. 6ins.
	The diameter " " ...	7ft. 3½ins.
	The length over headstocks to be	21ft. 6ins.
	Height of buffers from rail (unloaded) ...	3ft. 5ins.
	Centres of buffers apart	5ft. 8½ins.
	Wheel base not to exceed	12ft. 0ins.
	Diameter of wheels on tread not to exceed ...	3ft. 2ins.

Tare.

2. Tare not to exceed 11 tons.

Tank.

3. The tank is to be of the form shown on drawings herewith, and is to be provided with wash and stay plates. The barrel is to be made of $\frac{5}{16}$in. and the ends of ⅜in. Siemens' steel plates. The manhole at the top of tank to be provided with cover, pressure bar, and screw, so as to render the tank air-tight when the cover is closed. A horizontal bar indicating the level to which the tank may be filled is to be placed across the tank beneath the manhole at a height of 7ins. from the crown of the tank as shown on the drawing. The cover to have the following inscription cast upon it, "Tank must not be filled above bar below manhole." (Rest of this clause is the same as for 10-ton tank wagons.)

Painting of Tank.

4. The tank to be painted red and all writing to be in white.

Under-frame.

5. The under-frame to be of steel of approved quality (*vide* attached Specification*), and to the general design shown on the drawing. The minimum dimensions of the principal members are as follow:—

Headstocks, solebars, middle-bearers, diagonals, longitudinals, and tank side supports ...	10ins. by 3½ins. by ⅜in. channel bars
Trimmers	6ins. by 3½ins. by ½in. " "
Tank end support angles...	3ins. by 3ins. by ½in. angle bars
" supports ...	3ft. 3ins. by 1ft. 1in. by ⅜in. plate
" side brackets ...	3ft 3ins. in length by ⅜in. "

The whole to be so prepared that the ends have a good bearing upon the adjacent parts.

* Published in *Railway Engineer* for October, 1903.

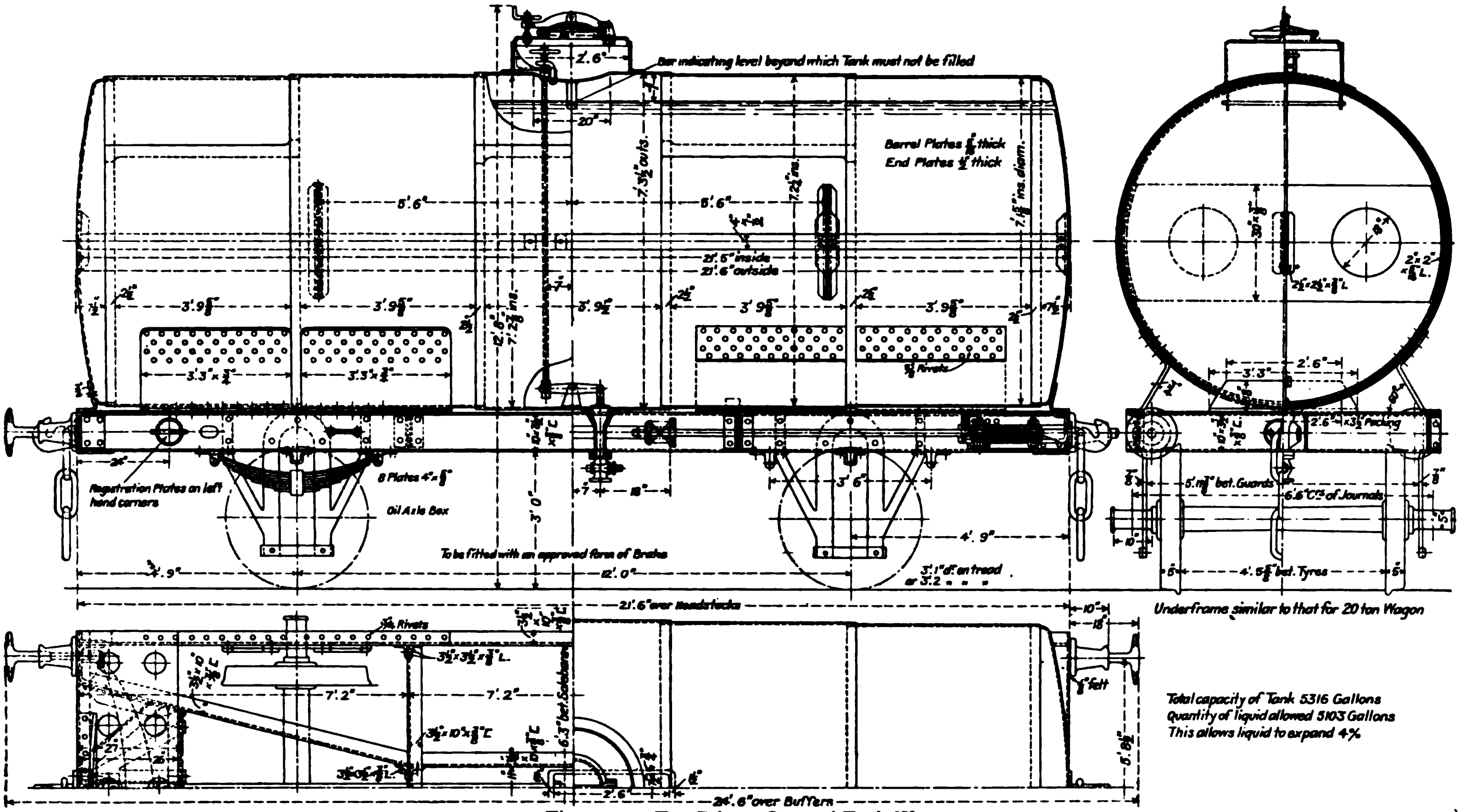


Fig. 1. 20-Ton Private Owners' Tank Wagon.

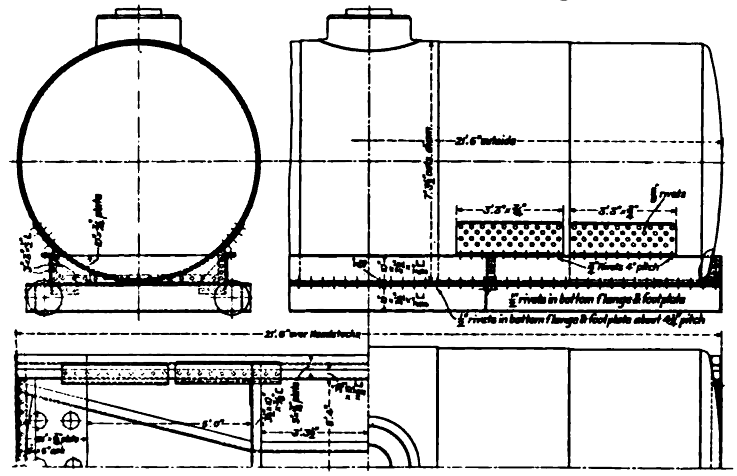


Fig. 2. Alternative Method of Securing Tank to Frame.

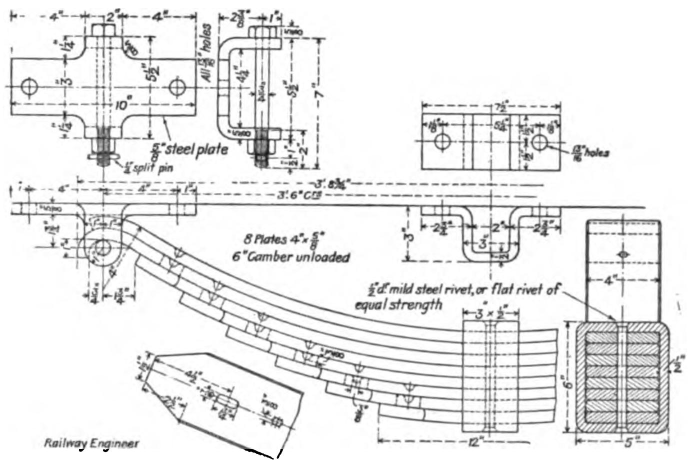


Fig. 3. Bearing Spring and Details.

Quality of Wrought Iron.

6. Same as for 10-ton tank wagons.

Drawgear.

7. Same as for 10-ton tank wagons.

Axle-guards.

8. The body of the axle-guards to be made of 4ins. by $\frac{7}{8}$in. iron, and the wings of $2\frac{1}{2}$ins. by $\frac{7}{8}$in.; the bottom stay or bridle to be $2\frac{1}{2}$in. by $\frac{5}{8}$in. The holes for the rivets are to be $\frac{11}{16}$in. diam., and must be drilled. Each axle-guard must be securely attached to the frame by 7 rivets, 3 of which are to be in the crown, and 2 in each wing.

Bolts and Nuts.

9. Same as for 10-ton tank wagons.

Brake.

10. Same as for 10-ton tank wagons.

Buffers.

11. Same as for 10-ton tank wagons.

Buffing Springs.

12. The buffing springs to be made of 14 plates of 3ins. by $\frac{1}{2}$in. steel, and to be tested at the maker's works by an Inspector, strictly in accordance with the Specification in clause 19 (*vide* Appendix† to this Specification). The spring buckle must be made of forged iron or steel, in accordance with the method shown in the detail drawing.

Bearing Springs.

13. The bearing springs to be made of 8 plates of 4ins. by $\frac{5}{8}$in. steel; to have 6ins. of cambre, unweighted, and a wrought iron buckle 3ins. by $\frac{1}{2}$in.; the plates to be secured in the buckle with a $\frac{1}{2}$in. mild steel rivet in middle. They must be made of approved material, and be tested at the maker's works by an Inspector, strictly in accordance with the Specification in clause 19 (*vide* Appendix to this Specification†).

†Published in *Railway Engineer* for February, 1905.

The bearing springs to be secured in position by bolts and nuts, as shown in standard drawings.

Axle-boxes.

14. Same as for 10-ton tank wagons.

Tyres.

15. Same as for 10-ton tank wagons.

Axles.

16. The axles to be made of Bessemer or Siemens' steel, and to be subjected to the tests set forth in clause 20 (*vide* Appendix to this Specification†). Wrought iron axles may be used if preferred, subject to the tests set forth in clause 21 (*vide* Appendix to this Specification†).

The axles to be 6ft. 6ins. in length from centre to centre of journals, $6\frac{3}{4}$ins. diam. through the boss of the wheel, and gradually tapered to 6ins. in the centre.

There must be no shoulder on the axle behind the boss. The journals to be 10ins. long by 5ins. diam., and the whole to be strictly in accordance with the drawing.

Wheels.

17. The body of the wheel to be made of wrought iron to the Specification attached.* The boss to be $6\frac{1}{2}$ins. through and 1ft. $0\frac{1}{2}$in. diam. The rim to be not less than $1\frac{1}{2}$ins. thick, soundly welded throughout, and turned exactly to 2ft. 9ins. diam.

The boss to be bored out, and the wheel forced on the axle by hydraulic pressure of not less than 50 tons. No keys are to be used.

If preferred, the body of the wheel may be of cast steel of approved design, the boss to be $11\frac{3}{4}$ins. diam.; other dimensions as above.

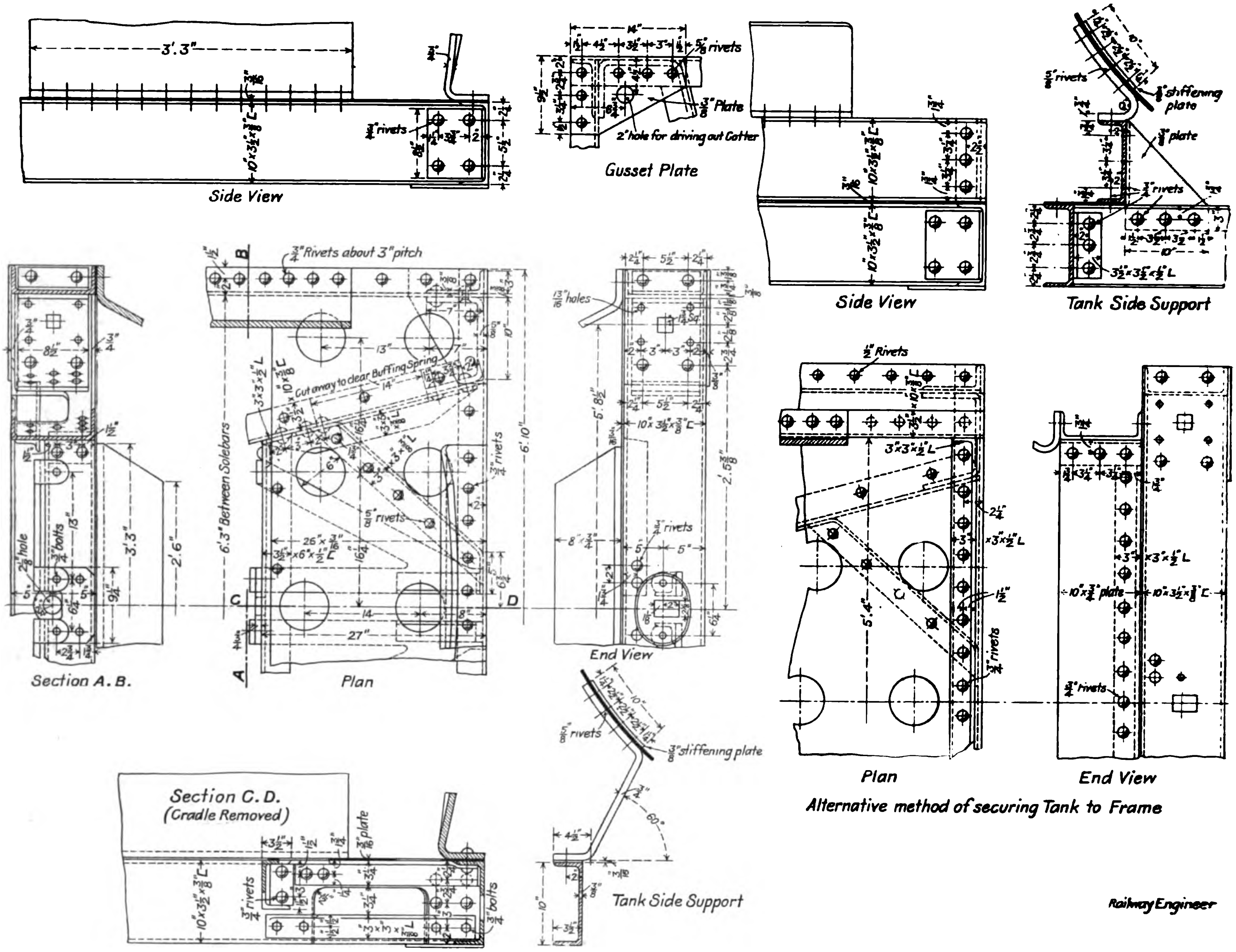


Fig. 4. Frame Details. 20-Ton Private Owners' Tank Wagon.

Stamping of Ironwork and Steelwork.

18. Ironwork and steelwork to be stamped distinctly with the name or initials of the owner.

The manhole, cover, loading bar and valve details are the same as for the 10 ton private owners' tank wagons (see *Railway Engineer*, March, 1905).

The drawbar hooks and couplings, drawbar plate, drawbar cradle (except length which is 2ft. 6in. inside), the intermediate drawbar, auxiliary draw spring and washer, wheels, tyres, axles axle-boxes, buffer and buffing spring, buffer guides and buffing spring shoe, axleguard and stay, and buffing spring cradle are the same as for the 20 ton private owners' wagons (see *Railway Engineer*, October, 1903).

The horse hooks (except the holes which are $1\frac{3}{16}$in. in diameter, and the flanges, which are $\frac{1}{2}$in. thick instead of $\frac{5}{8}$in) are the same as for the 15 ton private owners' wagons (see *Railway Engineer*, December, 1904).

† Published in *Railway Engineer* for February, 1905.

* Published in *Railway Engineer* for October, 1903.

The Campbell Reinforced-Concrete Sleeper, Elgin, Joliet and Eastern Railway.

New Use for Old Boiler Tubes.

Mr. R. B. Campbell, general manager of the Elgin, Joilet and Eastern R., has designed a reinforced-concrete sleeper which has been under test on that railway for some time. The section of the sleeper is rectangular, 7ins. wide and 6in. deep, with the corners bevelled off. Under the rails the sleeper is widened to 10ins. The length of the sleeper is 8½ft. The reinforcement consists of two scrap boiler tubes of 2¼ins. outside diameter (or one 3ins. tube), and 7ft. long, laid side by side, so that their ends overlap 7½ins. An additional reinforcement of common wire netting is placed around the tubes, as shown in the accompanying illustration, and a piece of heavy wire netting 6ins. by 8ins. is inserted in slots in the tubes, directly underneath the rail seats.

The bearings for the rails consist of sole-plates, and the fastenings of U-bolts which pass through the tie from underneath, extending up through the tie plate and screwed down upon clips which hold the rails in place.

The cost of manufacturing this tie in quantities is estimated at $1.50 to $1.75 each (6s. 3d. to 7s. 3½d.). Switch sleepers can be made of the same general design as ordinary cross sleepers, the principal difference being the preparation of molds for the sleepers of differing dimensions. On 7th September last 65 of these sleepers were placed in one of the main switching leads of the E., J. and E. Ry., where they have been subjected to the heaviest service possible, and no failure or deterioration has been observed. They have maintained the line in good surface and line, and apparently the frost has not affected them in the least.

Sixteen of these sleepers were subjected to breaking tests in a Reihle testing machine, and although they were cracked, they could still be used in the line, as they had bearing enough to support the traffic, and the reinforcing of the sleepers holds the rails to gage.

Table I. gives the proportions of the concrete tested.

All but Nos. 5, 7, 8 and 13 were tested by inverting the sleeper supporting it at the rail points and applying the load at the middle. The supports were 5ft. apart centre to centre, and consisted of blocks 3½ins. by 4¾ins. The results are shown in Table II. Loading was begun at 1,000lbs. and increased at the rate of 1,000lbs. up to 4,000lbs., after which the increments were

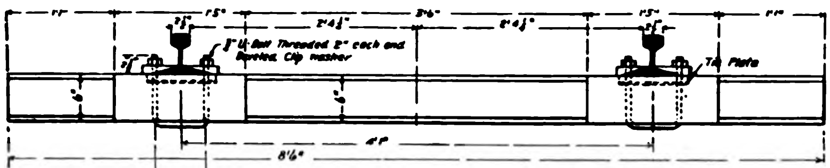
Table I.—*Proportions and Age of Concrete*

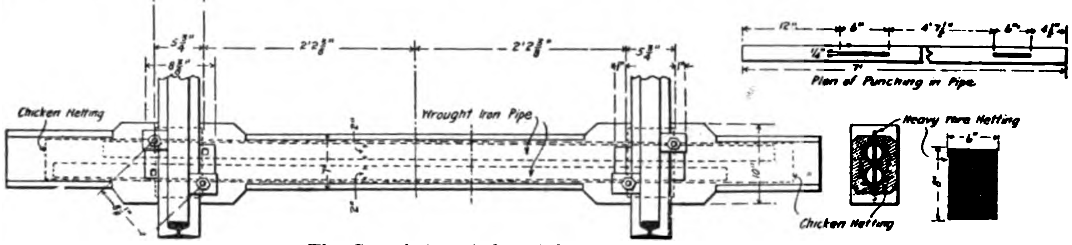
No.	Weight, Lbs.	Cement.	Sand.	Washed Lake Gravel.	Washed Bank Gravel.	Bank Gravel.	Slag.	Crushed Stone.	Limestone Screening.	Age of Sleeper in Days.
1	293	1	2	—	—	3	—	—	—	152
2	—	1	2	—	3	—	—	—	—	116
3	401	1	—	—	—	—	—	3	—	116
4	—	1	2	—	—	3	—	—	—	116
5	—	1	—	—	—	—	—	—	4	116
6	385	1	—	—	—	—	—	—	3	120
7	355	1	—	—	—	—	—	7	—	200
8	383	1	—	—	—	—	—	—	7	126
9	364	1	2	—	—	—	3	—	—	147
10	—	1	2	—	—	3	—	—	—	119
11	—	1	—	—	—	—	—	3	2	94
12	—	1	—	—	—	—	—	—	4	117
13	—	1	2	3	—	—	—	—	—	196
14	—	1	2	—	3	—	—	—	—	196
15	311	1	2	3	—	—	—	—	—	195
16	—	1	2	—	3	—	—	—	—	195

All except Nos. 13 and 16 were reinforced with wire netting.

Nos. 10, 11, 14, 15 and 16 had one 3″ diam. outs. tube and the rest two tubes 2¼″ outs. diam.

The "Universal" brand of cement was used for all except No. 4, in which the "Alpha" brand was used.





The Campbell Reinforced Concrete Tie.

Results of tests made of the Campbell Concrete Sleeper, at Hammond, on Riehle Testing Machine.

Table II.—Sleepers inverted and supported at the rail seats on blocks 3½in. by 4¾in., 5ft. centres apart. Pressure applied to a central plate, resting on bottom of sleeper, 11½in. by 10in.

Deflection of sleeper in decimals of an inch.

No.	1000 lbs	2000 lbs	3000 lbs	4000 lbs	4200 lbs	4400 lbs	4600 lbs	4800 lbs	5000 lbs	5200 lbs	5400 lbs	5600 lbs	5800 lbs	6000 lbs	6200 lbs	6400 lbs
15	·021	·046	·071	·101	·111	·119	·130	·135	·160	·163	·167	·177	·177	·181	·195	·206
11	·050	·068	·128	·190	·208	·209	·215	·221	·231	·250	·260	·271	·282	·302	·320	·345
9	·012	·034	·065	·152	·162	·171	·176	*·183	·194	·205	·214	·229	·241	·255	·279	·310
3	·032	·071	·112	·170	·185	·200	·220	·232	·246	*·272	·320	·425	†			
4	·012	·038	·076	·122	·132	·140	·149	*·152	·188	·200	·222	·300	†			
1	·020	*·040	·085	·155	·170	·200	·220	·250	·270	·300	·320	†				
2	·031	·042	·055	·079	·120	*·198	·220	·275	·305	·440	†					
6	·028	·066	·112	*·193	·220	·255	·285	·325	·365	·436	†					
16	·031	·050	·150	*·209	·285	·286	·292	·308	·351	·438	†					
12	·025	·062	·141	·235	·275	·318	·351	·435	†							
14			·151	*·184				·456	†							
10	·037	·069	·109	†												

No.	6600 lbs	6800 lbs	7000 lbs	7200 lbs	7400 lbs	7600 lbs	7800 lbs	8000 lbs	8200 lbs	8400 lbs	8600 lbs	8800 lbs	9000 lbs	9200 lbs	9400 lbs	9600 lbs	9800 lbs
15	·211	·218	·218	*·245	·245	·266	·266	·280	·280	·291	·312	·332	·348	·360	·392	·415	†
11	·354	·380	·404	·434	·461	·511	†										
9	·349	·421	†														

* Slight crack appeared. † Broke.

Table III.—Sleepers supported as before, but load applied through a wrought iron beam to blocks 9ins. from ends of sleepers, resting on bearing plates 10¾ins. by 11½ins.

Deflection of tie in decimals of an inch.

No.	1000 lbs.	2000 lbs.	3000 lbs.	4600 lbs.	5000 lbs.	5200 lbs	5400 lbs.	5600 lbs.	5800 lbs.	6000 lbs.	6200 lbs	6600 lbs.	7000 lbs.	7400 lbs.
8 ..					·161									
13 ..	·007	·015	·020	·035	·054	·054	·054	·056	·056	·056	·062	·070	·073	·077
7 ..					·070									

No.	7800 lbs.	8200 lbs.	8600 lbs.	9000 lbs.	3400 lbs.	9800 lbs	10000 lbs.	10200 lbs.	10400 lbs.	10600 lbs.	10800 lbs.	11000 lbs.	11200 lbs.	11400 lbs.	11800 lbs.	12200 lbs.	12600 lbs.	13000 lbs.	13400 lbs.	13800 lbs.	14200 lbs.
8 ..							·318					·370		·388	·410	·445	·479	·509	·521	·512	*
13 ..	·077	*·084	·085	·086	·087	·087		·088		·090		·093		·095	·099	·103	·104	*			
7 ..							*·365		·349		·400		·465			*					

* Broke.

reduced to 200lbs. and continued to the breaking point. No. 15 gave the best results, breaking at 9,800lbs., with an observed deflection at 9,600lbs. of 0·415in. No. 10 was the lowest, the break occurring at 4,000lbs. Nos. 3 and 4 broke at equal loads, as did 2, 6 and 16, and 12 and 14.

Nos. 7, 8 and 13, see Table III., had the pressure applied 9 ins. from each end of the inverted sleeper, supported, as before, at the rail points. The results show No. 8 to have broken at 14,200 lbs., with a deflection of 0·572 in.; No. 13 at 13,000lbs., deflection 0·104in.; No. 7 at 11,400lbs., deflection 0·465in.

No. 5 was subjected to a crushing test at the rail point, the pressure being applied to a plate 10½ins. by 11½ins. on top of the inverted sleeper, which had a plate 4½ins. by 12½ins. beneath it, next to the sole-plate. At 80,000lbs. a crack appeared on one side running vertically through the sleeper. Crushing came at 100,000lbs. The crushing test given to No. 5 was interesting, as it showed that the sleeper resisted a crushing load of over 1,350 lbs. per square inch.

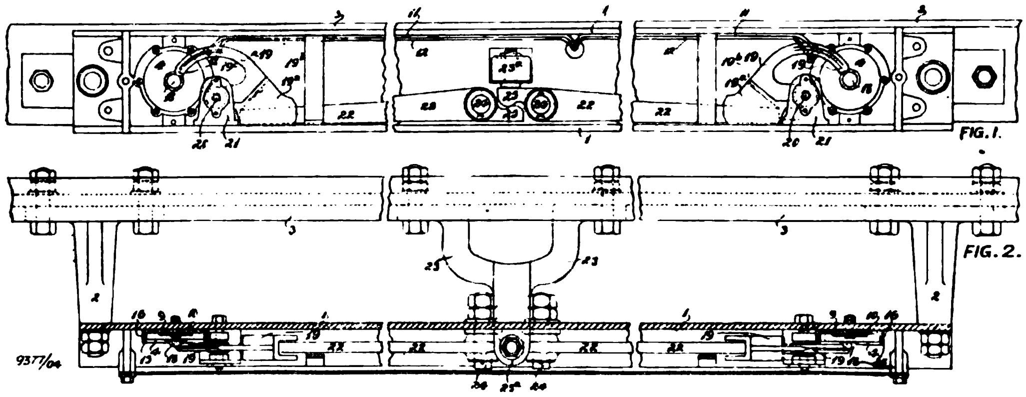
For the above illustration and particulars we are indebted to the *Railway and Engineering Review.*

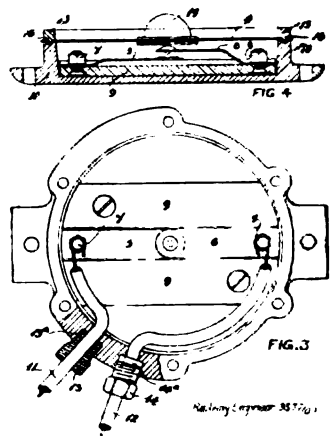
Recent Patents relating to Railways.

THESE abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d*. each.

Electric Contact-Makers for Signalling. *9,377. 23rd April, 1904. S. P. Wood and McKenzie and Holland, Ltd., Vulcan Iron Works, Worcester.*

Relates to an electric treadle or contact-making device, principally intended to be operated by the depression of the rail on which a train is standing or travelling. A box 10 in which the contacts 5, 6 and terminals 7, 8 are mounted is covered by a flexible diaphragm 4 of rubber or other material carrying a projection 18, adapted to be acted upon by arms 19, pivoted at 20 on the pedestals 21.

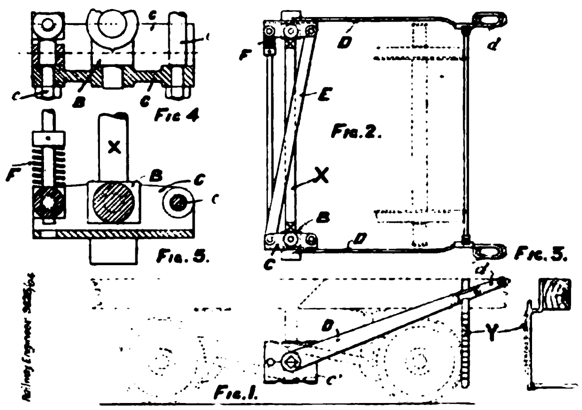




When the train or vehicle depresses the rail 3 the outer end of the arm 23 acts on the ends 25 of the levers 22, which operate the arms 19, causing them to bear against the projections 18 and thus close the contacts. (*Accepted 9th March, 1905.*)

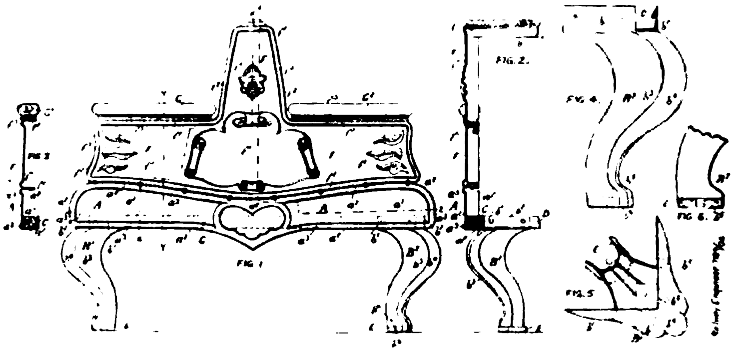
Brakes, Wagon. *9,826. 29th April, 1904. F. L. Martineau, 43, Westcroft Square, Hammersmith.*

The brakes are operated by the rocking action of a shaft X mounted centrally between the wheels of the vehicle and parallel to the axles. On each end of the shaft is fixed a block B, to which is pivoted by pivots arranged at right angles to the axis of the shaft X, a box C formed in two parts clamped together by bolts *c*, *c* as shown. To each box C is fixed an operating lever D, the free end of which is provided with a suitably shaped handle *d*, and is adapted to engage a rack Y of the usual type for retaining the brakes in their operative positions. By pivoting the operating levers at right angles to the axis of the shaft X the levers are free to rock both around the axis of the shaft X and also at right angles to it. The two levers D, D are coupled together by a link E, so arranged that the outward movement of either lever—such as would take place when the lever is moved to disengage it from



its rack—imparts a similar outward movement to the other lever, thereby also disengaging it from its rack. A spring or springs, such as F, may be employed to retain the levers D, D in contact with their racks Y, Y. (*Accepted 16th March, 1905.*)

Frames for Carriage Seats. *7,164. 25th March, 1904. A. E. Morgan, 112, Broadwell Road, Oldbury, Worcester.*

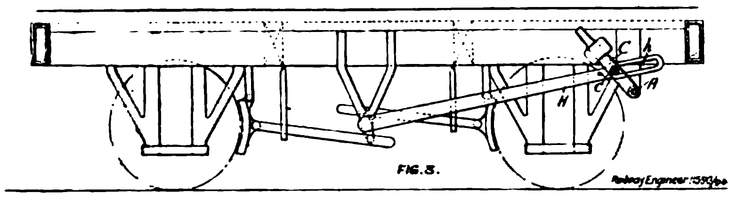


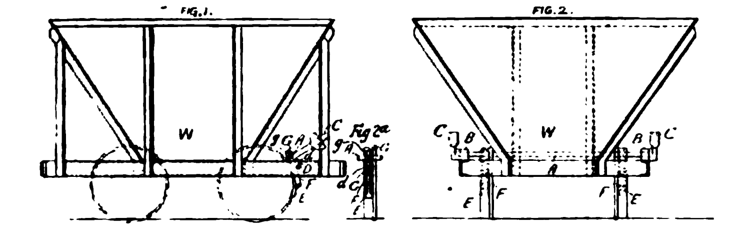
According to this invention a seat end frame for the combined seats and seat backs of railway carriages, tram cars or other cars having a passage up the middle, is formed of trough section sheet metal stampings A and F, supported by the stamped sheet metal legs B^1, B^2. The parts are shaped and arranged as shown in the illustration. (*Accepted 2nd March, 1905.*)

Brakes, Wagon.—*11,590. 20th May, 1904. A. S. Nelson of the firm of Hurst, Nelson and Co., Ltd., The Glasgow Rolling Stock and Plant Works, Motherwell, Lanark.*

This invention relates to either side brakes and comprises a rock shaft A carried in bearings B transversely of the under frame of the wagon W and having secured on its ends at each side of the wagon body a weighted hand or foot lever C similar to that used in operating railway switches, and projecting upwardly from the shaft A. The cross shaft A has fixed on it at suitable points under the wagon, lever arms D having projecting pins *d* which, when either weighted lever C is pulled over to apply the brake, are

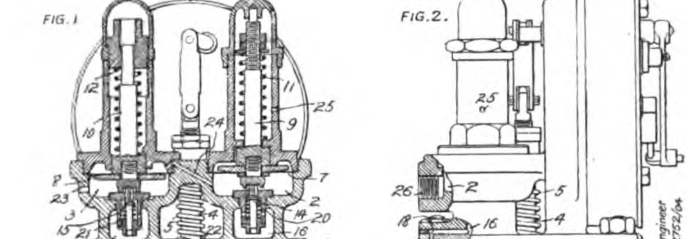
brought to bear on the back of the brake blocks E, or (as shown in figs. 1 and 2[a]) of the links F from which the blocks are suspended, or on rods or links connected to the brake blocks or their actuating levers. The throwing over of the weighted lever C at either side of the wagon is effected by hand, and pressure may be further applied by the attendant mounting the wagon and placing his foot on the lever end which is then brought into a nearly horizontal position. The brake remains applied until the attendant throws back the weighted lever C over the pivot formed by the cross shaft A whereupon the weight carries the lever downward to a nearly horizontal position on the opposite side, and a second lever arm G, or set of arms on the cross shaft A and having pro-





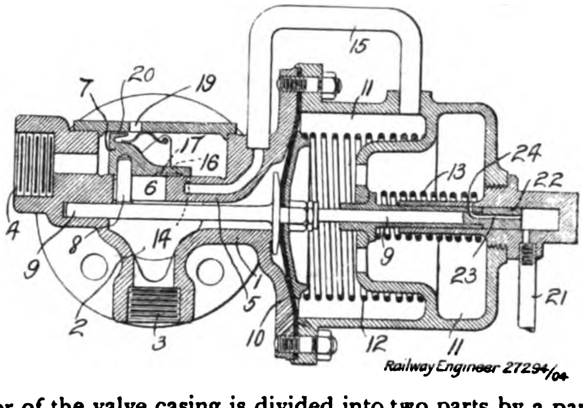
jecting pins *g*, is brought to bear against the inner side of the brake block links or levers F to lift the brake blocks off the wheels. In the modification shown at figs. 3 and 4 the weighted hand lever C on the cross shaft A has on it a projecting stud *c* which enters a slot *h* in a lever H which takes the place of the ordinary brake lever. In this case the hand lever C is shown in the position for freeing the brakes, but by throwing the hand lever to the right to bring the stud *c* to the opposite end of the slot *h* the lever H is depressed and the brakes applied. (*Accepted 23rd March, 1905.*)

Vacuum Brakes. *12,752. 6th June, 1904. The Westinghouse Brake Co., Ltd., and J. J. Elmer, 82, York Road, King's Cross, London.*
This invention provides means for automatically cutting into and out of operation the exhaust pump, ejector, or other device employed for creating the necessary vacuum in the brake apparatus, according as the vacuum rises above or falls below a predetermined degree. A casing is formed with three chambers, 1, 2, 3, each of which is provided with a flexible diaphragm dividing the chamber into two parts. To the diaphragm 6 in the lowermost



chamber 1 is attached a stem 4 surrounded by a spring 5 so adjusted as to tend to move the stem in an upward direction. The movement of this stem serves to open and close a switch for cutting into and out of operation the electric motor operating the exhaust pump. The diaphragms 7, 8 in the upper chambers 2, 3 are also provided with stems 9, 10 and springs 11, 12. The spring 11 is arranged so as to tend to move the stem 9 in an upward direction, while the spring 12 is so adjusted that it tends to force the stem 10 in a downward direction. In the lower parts of the chambers 2, 3, valves 14, 15 are arranged adapted to control communication between the chambers 2, 3 and two further chambers 16, 17, respectively, both of which communicate through two sets of passage ways 18, 19 (see fig. 2) with the chamber 1 on the under side of the diaphragm 6. The valves 14, 15 are adapted to be opened and closed by the movements of the diaphragms 7 and 8 and are provided with springs 20, 21 tending to hold the valves to their seats. Leakage passages 22 and 25 are provided leading from the atmosphere to the upper side of the diaphragms in chambers 1 and 2 respectively, and an orifice 23 is provided leading from the atmosphere to the under side of the diaphragm in chamber 3. That part of the chamber 2 below the diaphragm is connected by means of a passage or channel 24 with that portion of the chamber 3 which is above the diaphragm 8. Chamber 2 on the under side of the diaphragm is connected at 26 (see fig. 2) with the train pipe of the brake apparatus. In the position shown the degree of vacuum existing in the train pipe is less than the normal, and the switch is consequently closed and the exhaust pump in operation to raise the degree of vacuum. Under these circumstances the pressure in the chamber 2 on the under side of diaphragm 7 assisted by the spring 11 is sufficient to raise the diaphragm so as to maintain the valve 14 closed and communication between the chamber 2 and the lowermost part of chamber 1 through the chamber 16 and passages 18 and 19 is therefore cut off. The combined forces of the spring 12 and the pressure on the upper side of diaphragm 8 are, under the conditions mentioned, sufficient to force down the diaphragm 8 and open the valve 15, thereby establishing communication between the chamber 1 on the under side of the diaphragm and the atmosphere through the second set of passages 18, 19, chamber 17, value 15, chamber 3 and orifice 23. The pressures on either side of the diaphragm 6 being therefore atmospheric the spring 5 will force the stem 4 in an upward direction to that position in which the switch is closed and the electric circuit to the motor completed. (*Accepted 23rd March, 1905.*)

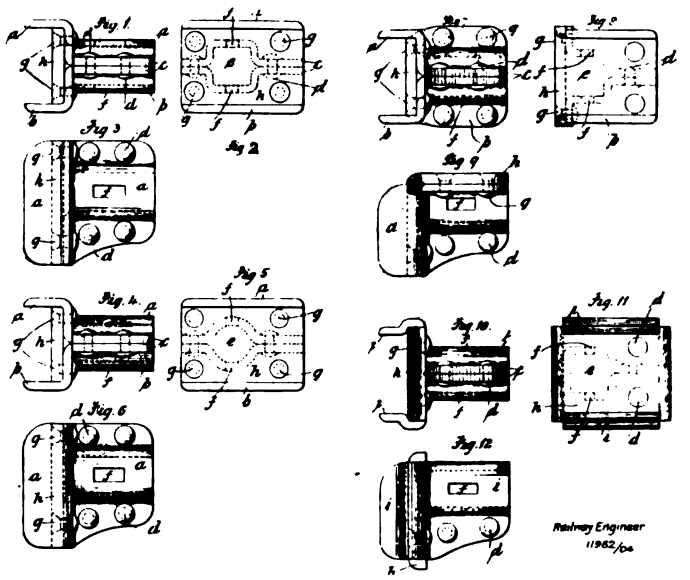
Vacuum Brakes. *27,294. 14th December, 1904. J. W. Cloud, 82, York Road, King's Cross, London.*
This invention has reference to apparatus as described in Patent No. 14,318[04], in which a reservoir external or supplemental to the brake system, normally containing air at atmospheric pressure, is arranged to be put into communication with the train pipe when the brakes are to be applied. The communication is controlled by a valve to which the present invention relates. The



interior of the valve casing is divided into two parts by a partition 5 having a port 6, with which co-operates a slide valve 7 operatively connected through a pin 8 with a stem 9 attached to a diaphragm 10, which divides the interior of the casing 1 from an operating chamber 11; the diaphragm 10 is normally maintained in the position shown in the drawing by springs 12, 13. In addition to the port 6, the partition 5 is provided with a port 14 connected through a pipe 15 to the operating chamber 11, and adapted to co-operate with a port 16 in the slide valve 7, port 16 being provided with a small cavity 17. The casing communicates with the atmosphere through a port 19, and there is provided a small amount of clearance between the slide valve 7 and the portion of the casing containing the atmospheric port as indicated as 20. The operating chamber 11 is connected through the pipe 21 with the brake cylinder, the entrance to the pipe being opened and closed by a projection 22 from the stem 9, which is carried by the diaphragm 10, the projection having a

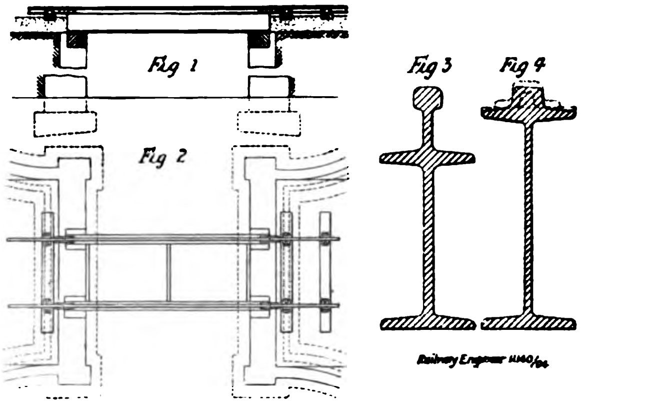
channel 23 co-operating with an orifice 24 in a tube surrounding the stem. On a sudden small increase of pressure being made in the train pipe, the diaphragm 10 is moved against the pressure of its controlling spring 12 and carries with it the slide valve 7, which opens communication between the train pipe 2 and the supplementary reservoir through the port 6. The atmospheric port 19 being covered by the slide valve, air from the atmosphere can also pass into the supplementary reservoir or into the train pipe through the small clearance space 20. At the same time the operating chamber is connected with the atmosphere through pipe 15, ports 14, 16, and the clearance space 20 and port 19, also the plunger 22 covers the entrance to the pipe 21 and thereby closes the connection between the brake cylinder and the operating chamber 11. The pressure in the operating chamber will therefore rise to that in the train pipe by reason of air entering from the atmosphere through pipe 15 until it becomes approximately equal to that in the train pipe, whereupon the spring 12 moves the diaphragm 10 back to its normal position, thereby closing the port 6 and permitting the supplementary reservoir to become fully charged through the atmospheric port 19. When a large increase is suddenly made in the pressure in the train pipe, the slide valve 7 is moved to the limit of its travel compressing the spring 13 as well as the spring 12 and opens the train pipe and supplementary reservoir to the atmosphere through the port 19 at the same time air from the atmosphere is admitted to the operating chamber 11 through port 16, cavity 17, port 14 and pipe 15, and as soon as the pressure in the operating chamber approaches sufficiently near that in the train pipe, the springs 12 and 13 will operate to return the diaphragm 10 and slide valve 7 to their normal positions. It will be seen, however, that owing to the small size of the cavity 17 in the slide valve the flow of air to the operating chamber is restricted and the rise of pressure in this chamber retarded, by which means the return movement of the diaphragm 10 and valve 7 to their normal positions will be delayed long enough to ensure the desired acceleration of the full application of the brakes. After the diaphragm 10 is returned to its normal position, the pressure remaining in the operating chamber 11 can be withdrawn through port 24, passage 23 and pipe 21, by way of the brake cylinder when the brakes are released. (*Accepted 30th March, 1905.*)

Buffers. *11,962. 26th May, 1904. W. Gatwood, general manager of The Steel Railway Journal Box Co., Ltd., Pendleton, Manchester.*
Buffer spring shoes or casings are formed from a single wrought



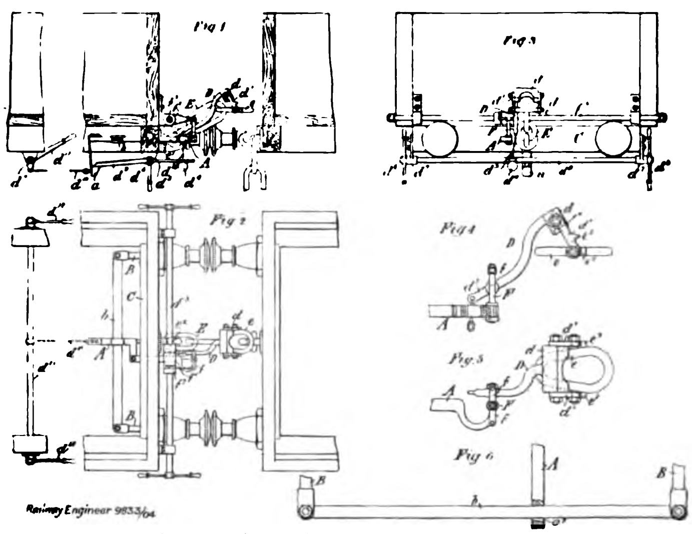
iron or steel plate, or from two plates, by first heating and then pressing the plates to the required shape. When one shaped metallic plate only is used to form the body of a shoe it is bent or folded by mechanical means around a metallic mandrel, the required number of holes are then drilled or punched through the flanges of the blank to enable them to be secured against each other by iron or steel rivets, a cylindrical, a square or other shaped longitudinal hole being formed between the sides of the shoe-body according to the transverse section or outline of the end of the buffer-rod it is intended for. If two pressed or shaped metallic plates are used they are placed back to back or their flanges against each other, the required number of holes drilled or punched through such flanges and rivetted together. A suitably shaped metallic bearing plate is then rivetted against one end of the shoe-body between their wings and a pin hole or cotter hole drilled or punched in desired position transversely through the side of the shoe. (*Accepted 30th March, 1905.*)

Railway Bridges. *11,140. 14th May, 1904. A. b. Geen, Kingsthorpe, The Avenue, Berrylands, Subiton.*
According to this invention, the rail and girder or joist, in short span bridges, are rolled in one piece. The joist is erected as part of the structure of the bridge in the usual way; the head and the



web of the rail being integral with the joist and presented uppermost. When the joists have been fitted the railway track is already laid, the joists being erected in such position that the rail-forming portions are in line with, and form a continuation of, the rails leading up to the bridge. (*Accepted 23rd March, 1905.*)

Couplings, Automatic. *9,833. 29th April, 1904. F. M. Harvey and H. C. Harvey, 5, Trewartha Terrace, Penzance, Cornwall.*
A plunger A is either mounted in a separate casing or connected with the ordinary buffers. It is connected with the buffer stems through a bar *b*, and carries a pivoted lever D, from which a coupling chain of ordinary form is suspended by links d^1 connected to the outer link *e* of the coupling. The link *e* is raised



into the coupling position by operating a transverse shaft d^6, provided with a lever arm a^5 which is connected with lever D by a chain d^3. This chain also carries a counter weight for the lever D. To retain the lever D in the coupling position, a catch *a* is provided attached to the plunger A, and with this catch engages a lever d^9 formed on the shaft d^6. The catch is so arranged that, when desired, it may be held out of position for engaging with the lever d^9. For this purpose the end of a chain d^{10} is attached to the catch *a*, whilst its opposite end is connected to a

shaft d^{11} provided with levers d^{12} d^{12} by which the shaft is vibrated and the catch a held out of position for engaging the lever d^9. To prevent the free end of the coupling-link e rising to such an extent as to strike the head d of the pivoted lever D, there is formed on either side of the link a projection e^2 adapted to contact with stops e^3, one on each of the suspending links d^1 d^1. Stops e^4 are also provided on the head d of the lever D, so that, when the latter is raised into operative position for coupling, the suspending links d^1 d^1 contact with the stops e^4 and hold the coupling link in position for coupling. For the purpose of uncoupling, a chain or chains may be connected to the pivoted lever, and pass, by way of suitably disposed guide pulleys, to the sides of the wagon. By pulling one of the chains, the head of the lever may be lifted together with the coupling link, thus releasing the latter from its hook and affecting the uncoupling of the wagons. The automatic coupling is effected, on two vehicles coming together, by the action of the buffers which cause the plunger A and lever D to be drawn back thus releasing the lever from its catch. (*Accepted 16th March, 1905.*)

SPECIFICATIONS PUBLISHED.

1904.

2999. Manufacture of brasses or bushes for bearings. Tomson and Hanna
5064. Electric and automatic working of signals, points, and crossing gates. Daboo.
5274. Coupling combined with brake connector and valve opener. Williams and Williams.
5634. Switch point and frog for the overhead equipment of electric traction. Bonthrone.
6738. Antifriction mechanism for trucks and other vehicles. Cross (Rinuy).
7164. Seat frames. Morgan.
7428. Apparatus for electrically operating railway and tramway points. Tierney and Malone.
8064. Working of single lines on the electric staff or other electric systems. Jacobs.
8244. Apparatus for placing tramcars or like vehicles on or removing them from the rails. Jones.
9235. Sand box for tramcars and locomotives. Shaw and Kidman.
9377. Electric treadles or contact makers for railway signalling. Wood and Mackenzie and Holland, Ltd.
9540. Tramway points. Edgar, Allen and Co., Ltd., and Robinson.
9654. Means for stopping trains independently of driver. Schreiner.
9657. Brakes for tramcars and similar vehicles. Fidler.
9743. Locks for carriage doors. Galley and Bolt and Lock Syndicate, Ltd.
9826. Wagon brakes. Martineau.
9833. Wagon couplings (automatic). Harvey and Harvey.
9985. Crossings specially applicable for the intersection of tramway lines with those of small railways. Hettstedt.
10021. Fluid pressure brake systems. British Thomson-Houston Co., Ltd. (General Electric Co.)
10545. Point and signal apparatus. Dutton and Mackenzie and Holland, Ltd.
10812. Overhead trolleys or collectors for electric tramway and railway vehicles. Blaney.
10877. Fluid pressure brakes. British Thomson-Houston Co., Ltd. (General Electric Co.).
11140. Railway bridges. Geen.
11195. Bearings for railways and like cars. Dorn.
11287. Destination or route indicators. Walker.
11590. Wagon brakes. Nelson.
11591. Means for opening and closing bottom doors of wagons. Nelson.
11647. Fog-signalling apparatus. Clayton.
11962. Buffing spring shoes. Gatwood.
12143. Portable tramways or railways. Pinkerton.
12530. Rail joints. Ambert.
12752-3. Pneumatic brake apparatus. Westinghouse Brake Co., Ltd., and Elmer.
15061. Signalling apparatus. Thompson (Weatherley Electric and Manufacturing Co.).
17025. Brake blocks. Haddan (Lachaud).
17085. Brake. Fgetz and Salzberger.
18756. Street railway cars. Goehring.
22351. Dumping wagons. Morgan.
22781. Car couplings. Gudich.
22826. Lock nuts. Beckett.
22839. Method of supporting overhead wires of electric tramways. Allen.
24295. Signals. O'Driscoll.
24352. Vacuum brakes. Cloud.
25118. Safety device for stopping trains. Knorn.
27294. Vacuum brakes. Cloud.
27686. Rail ties or sleepers and fastenings. Anderson.
28060. Locomotive tube boilers. Schmidt.
29509. Lock or safety catch for carriage doors. Fondu.

1905.

152. Automatic block signalling system. Richardson.
2580. Fluid pressure brakes. Turner and Blackall.
2757. Passenger vehicles. Sergeant and Lindall.

Proposed New Regulations for the Use of Locomotives and Wagons on Lines and Sidings in connection with Factories and Worshops.

THE Home Secretary has issued a draft (printed below) of the regulations which he proposes to make under Section 79 of the Factory and Workshop Act, 1901, for the use of locomotives and wagons on lines and sidings in or in connection with premises under the Act. The regulations are not in their final form but in draft only, and subject to revision if found desirable.

The Secretary of State has considered it necessary to certify this description of work as dangerous, and to frame regulations in view of the large number of accidents in the United Kingdom in connection with the use of locomotives or other moving railway plant which have been reported in recent years on premises under the Factory Act. The following is the number of accidents reported to the Inspectors of Factories during the years 1902 and 1903:—

	Factories and Workshops.		Docks, &c.		Totals.		
Year.	Fatal.	Non-fatal.	Fatal.	Non-fatal.	Fatal.	Non-fatal.	Totals.
1902	75	403	19	95	94	499	593
1903	52	442	17	76	69	518	587
Totals	127	845	36	171	163	1,017	1,180

These figures, in the opinion of the Secretary of State, sufficiently indicate the need for further precautions being observed, and the Secretary of State thinks that the code which is now being issued in draft is reasonable, and when carried out is likely to reduce very considerably the number of accidents.

The use of locomotives in factories was enquired into by the Departmental Committee on Dangerous Trades in 1896, and the chief sources of danger were indicated in their Report* (pages 13 and 14). At that time, however, there was no power to deal with accidents occurring on lines or sidings used in connection with a factory but not forming part of it. This power has now been given in regard to all such sidings, excepting those which form part of a railway under the jurisdiction of the Board of Trade, by Section 106 of the Factory Act, 1901. The draft regulations are based in the first instance on the recommendations of the Committee, but since their Report much further careful enquiry has been made and additional information collected, and the Secretary of State has also had the advantage of consulting with the advisers of the Board of Trade and of examining the regulations made by the Board under the Railway Employment (Prevention of Accidents) Act, 1900. So far as possible where the regulations deal with a matter already dealt with in the Board's regulations the same terms have been adopted.

The regulations will apply to:—

(*a*) All lines and sidings in a factory or workshop, or in any dock or other place or premises to which Section 79 of the Act is applied.

(*b*) All lines or sidings used in connection with any factory, workshop, or other such place as aforesaid, and not being part of a railway used for the purposes of public traffic.

If objections of substance are taken to the proposed regulations printed below either by the occupiers, or the workpeople, or by any other persons affected, these objections will under the statute be the subject of full enquiry by a competent person appointed by the Secretary of State, and the report of the person holding the enquiry will be considered by the Secretary of

* This Report (C. 8149) may be obtained, price 3½d., from Messrs. Wyman and Sons, Fetter Lane, E.C.

State before the final regulations are made At the enquiry employers, owners, occupiers, and workpeople, and all others concerned, will be entitled to a full hearing.

If therefore any person desires the regulations to be further considered, he should lodge objection in accordance with Section 80 of the Factory and Workshop Act, 1901, and in pursuance of that section the Secretary of State gives the following notice:—

> That he proposes to make regulations, dealing with the use of locomotives and wagons on lines or sidings in or in connection with premises under the Factory and Workshop Act, in accordance with the enclosed draft, copies of which may be obtained on application to the Factory Department, Home Office, London, or at the local offices of the Inspectors of Factories, and that any objection with respect to the draft regulations by or on behalf of any person affected thereby must be sent to the Secretary of State within 40 days from this date. Every such objection must be in writing, and must state (*a*) the draft regulations or portions of draft regulations objected to; (*b*) the specific grounds of objection; and (*c*) the omissions, additions, or modifications asked for.

Regulations for use of Locomotives and Wagons on Lines and Sidings in connexion with Factories and Workshops.

It shall be the duty of the occupier or occupiers to comply with Regulations 1, 2, 3, 4, 6, 13, 14, 16.

It shall be the duty of the occupier or occupiers and of all agents, workmen, and persons employed to comply with Regulations 5, 7, 8, 9, 10, 11, 12, 15, and 17.

In these regulations—

Line of rails means a line of rails for the use of a wagon, locomotive, or travelling crane, other than an overhead travelling crane.

Wagon includes any wheeled vehicle or travelling crane on a line of rails.

Locomotive includes any wheeled motor on a line of rails used for traction of wagons.

Clear space at side.

1.—(*a*.) Except at junctions the distance between any two lines of rails shall be not less than 4ft., nor less than is sufficient to afford 2ft. 4ins. clear distance between the sides of wagons or locomotives on adjacent lines; and in computing this distance any load carried at a less height from the rail than 6ft. 6ins. shall be deemed to be part of the wagon on which it is carried. The distance between a line of rails and any fixed structure above the ground level, other than a platform for loading or unloading, shall not be less than is reasonably sufficient for the safety of persons working at or passing that point.

(*b*.) No wagon or locomotive shall rest at any point near to a junction if the distance between adjacent lines of rails at that point is less than 4ft. Provided that this part of this Regulation shall not apply to temporary stoppages for purposes of safety.

(*c*.) No heap of any material shall be allowed within 3ft. of a line of rails.

(*d*.) Point rods and signal wires in such position as to be a source of danger to persons employed shall be sufficiently covered or otherwise guarded.

(*e*.) Ground-levers working points shall be so placed that men working them are clear of adjacent lines, and shall be placed in a position parallel to the adjacent lines, or in such other position and be of such form as to cause as little obstruction as possible to persons employed.

(*f*.) Lines of rails and points shall be periodically examined and kept in efficient order.

Gantries.

2. Every gantry shall be properly constructed and kept in proper repair. It shall have a fixed structure as stopblock at the end, and shall be provided with hand-rails at the side distant not less than 4ft. from the end of rails.

Crossings.

3. Where persons employed have to cross over a line of rails on the level a reasonably safe crossing shall be provided, and for the purpose of this regulation no crossing between two wagons on the same line of rails shall be deemed to be reasonably safe unless the wagons are at least a wagon's length apart.

4. Where a level crossing over a line of rails is in frequent use by persons employed the Chief Inspector of Factories may, if satisfied that it is dangerous, give written notice to that effect to the occupier, who shall thereupon within a period to be specified in the notice take steps to prevent the use of the level crossing or provide a bridge or subway for the use of such persons.

Coupling.

5.—(*a*.) Coupling poles or other suitable mechanical appliances shall be provided for the purpose of coupling and uncoupling wagons and locomotives.

(*b*.) Wagons and locomotives shall not be coupled or uncoupled except by means of a coupling pole or other suitable mechanical appliance.

Movement of Wagons and Locomotives.

6. Proper sprags or scotches shall be provided for the use of the persons in charge of the movement of wagons.

7. The movement of wagons on a line of rails by means of a prop or pole, or by means of towing by a rope or chain attached to a locomotive or wagon moving on an adjacent line of rails, shall not be allowed where other reasonably practicable means can be adopted; and in no case shall props be used for the purpose unless made of strong timber hooped with iron to prevent splitting.

8. No wagon shall be pushed before a locomotive, unless a workman accompanies the front wagon.

9. No person shall be upon the buffer of a locomotive or wagon in motion.

10. No locomotive or wagon shall be moved until warning has been given by the person in charge to persons whose safety is likely to be endangered thereby, and when possible acknowledged by them.

11. No locomotive or wagon shall be moved during the period between one hour after sunset and one hour before sunrise, or in foggy weather, unless a red lamp is exhibited on the approaching end.

12. The driver of a locomotive shall sound the whistle as a warning on approaching any level crossing or any curve where sight is intercepted, or any other point of danger to workmen, and shall have the locomotive under control so that he can stop short of the point of danger.

Young Persons not to Drive or Shunt.

13. No person under 18 years of age shall be employed as a locomotive driver or shunter.

Steam and Water Gauges.

14. All boiler gauge glasses on locomotives or stationary steam boilers shall be protected by a covering or guard, sufficient to guard against accident to persons employed through the gauge glass breaking.

Water gauges or similar devices shall be provided on locomotives or tenders to indicate the amount of water in the tanks, and shall be in such a position as to be visible and accessible to the persons in charge without their incurring undue risk of injury.

Wagons under Repair.

15. A danger signal shall be attached to each end of any wagon or train of wagons undergoing repair.

Lighting.

16. Efficient lighting shall be provided where shunting is frequently carried on after dark, and at all points where necessary for the safety of the persons employed.

17. The following regulation shall apply to every capstan worked by power and used for the purpose of traction of wagons on lines of rail:—

(*a*) The ground around the capstan shall be kept clear from the obstruction.

(*b*) The mechanism of the capstan shall be maintained in efficient condition, and if operated by a treadle shall be examined on each day of use.

(*c*) The capstan shall not be set in motion until signals have been exchanged between the man in charge of the capstan and the man working the rope or chain attached to it.

(*d*) No wagon shall be hauled by means of a capstan unless the hauling rope or chain is attached to the wagon by the coupling hook of the wagon, and by no other part thereof.

(*e*) No person under 18 years of age shall work the capstan.

18. These regulations shall come into force on ———

Reinforced Concrete. II.*

Floors.

One of the chief advantages in the use of this material is the ease with which the different components are prepared and put together. A few skilled foremen can carry out the work quite well even if the rank and file of the majority of the workmen have had no previous experience in the use of metal and concrete in juxta-position, and as it is not usual for unskilled workmen to belong to a trades union, the labour employed is to this extent free from trade disputes and harassing conditions arising therefrom.

When concrete is reinforced with steel it is, of course, very much lighter in its dead load, and the material may be employed in situations where the earlier type of simple concrete floor or jack arch floor would be inadmissible on account of the great weight, which would entail more expense in construction and greater thickness in the floors themselves, thicker walls and more elaborate foundations.

The fixing of the wooden staging and centres requires some amount of care and skill, but the workmen easily get into the run of the thing and perform the work with facility.

The Hugo Bilgrim machine shops at Philadelphia was one of the first buildings of this material erected in that city. The design is for a five storey building, the stories being from 10ft. to 14ft. 8ins. in height, and as the present article is to be devoted to floors alone, the description of other parts of the building wil be omitted. The columns supporting the floors are in longitudinal rows 18½ft. apart across the building, the distance between the columns in the long direction being 14ft. 4ins. Between the columns longitudinally are reinforced concrete beams 14ins. by 10ins., fig. 1, having a span of 14ft. 4ins., and these cross beams carry transverse beams 12in. by 6ins., fig. 2, spaced 3ft. 7ins. centres. Upon the transverse beams rests a slab floor 4ins. thick in the lower and 3ins. thick in the upper floors, this slab of reinforced concrete being in its turn covered with 1¼in. floorboards, nailed to 3ins. by 2ins. strips embedded in a 2ins. thickness of cinder concrete. The first floor was designed to carry a uniformly distributed load of 300 lbs. per sq. ft., the second floor 200 lbs. and the remaining floors 150 lbs. per sq. ft. The floor slabs are reinforced with ¼in. round rods spaced 6ins. centres, and the beams both ways are reinforced with 1in. rods, as shown in figs. 1 and 2; the stirrups are made of two ¼in. twisted rods which tie the tensional members together. The centreing was formed of 2ins. planed planks, and 1½ins. of concrete was laid on these and thoroughly tamped before any of the reinforcing rods were introduced. The straight rods were laid first with the twisted rod hangers and another inch of concrete was added. The inclined rods were then laid and held in position until the remainder of the concrete was laid. When the concreting was finished for the day care was always taken to leave off the slabs over the centre of a beam, and the reinforcing rods were left

*No. 1 appeared in *The Railway Engineer*, May, 1905.

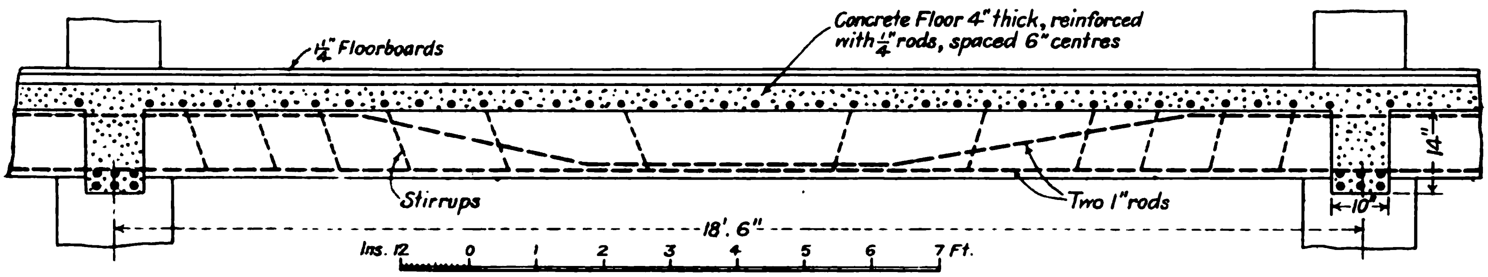


Fig. 1

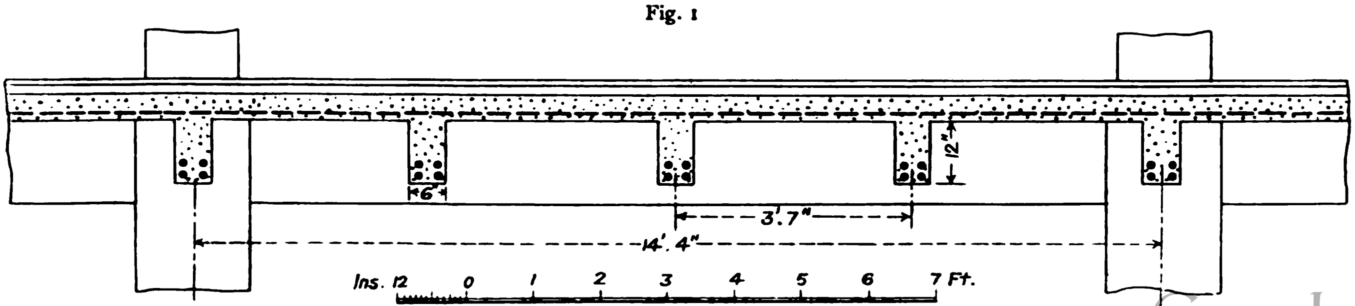


Fig. 2

projecting, so as to bind with the next day's work. The maximum stress allowed on the concrete was 500 lbs. per sq. in. and 16,000 lbs. per sq. in. on the steel. The concrete was composed of 1 part Portland cement, 3 parts gravel, and 5 parts broken trap rock, not larger than $\frac{3}{4}$in. in any direction.

The warehouse of J. M. Bour and Co., Toledo, Ohio, has floors very similar to the above, excepting that the bays of flooring are spaced at 5ft. 6ins., and the slabs are 5ins. thick with $\frac{1}{4}$ in. round rods placed at 3 ins. centres. The rods are extended over at least three bays of flooring, with the joints made to break evenly. The beams between the columns are 15ins. by 10ins. and have a span of 16ft. 6ins., and between these are transverse beams 5ft. 6ins. centres, 14ins. by 4ins. These beams are reinforced with straight and inclined rods much as in figs. 1 and 2, but there is a corbel projecting one foot of the same thickness as the beam at each column. The steel rods are generally round, and were specified to have an elastic limit of 30,000 lbs. to the sq. in., the strength of the concrete being assumed at 500 lbs. per

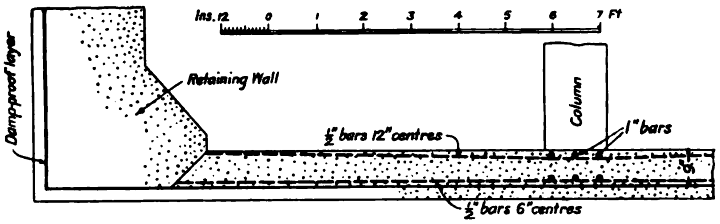


Fig. 3.

by these rods into the footings of the side walls as shown by fig. 3. The upper floor in this building is arranged as indicated in fig. 4, and has continuous slabs $7\frac{1}{4}$ ins. thick in which are laid $\frac{1}{2}$in. bars $7\frac{1}{4}$ins. apart, the slabs being carried by beams 18 ins. by 12 ins., the depth being included with the thickness of the floor slab.

The Robert Gair warehouse in Brooklyn has eight floors and a basement, each 13ft. 4ins. in height, and the floor load adopted was 200lbs. per sq. ft. The columns (which are of reinforced concrete along with all the floors) are spaced 16ft. 4ins. centres, and the girders, therefore, have this span. The main girders are $14\frac{1}{2}$ins. deep, exclusive of the thickness of the floor slab, and are 12ins. wide. The secondary girders are spaced at 5ft. $5\frac{1}{3}$ins. centres, and are 11ins. deep and 7ins. wide, and have a length of 16ft. centres of columns. The floor is $4\frac{1}{2}$ins. thick, and is reinforced with $\frac{5}{16}$ins. Ransome bars arranged as shown in fig. 5, the top surface being finished off with $\frac{3}{4}$in. granolithic.

The floors in the shops of the United Shoe Machinery Co., Beverly, Mass., figs. 6 and 7, are of 20ft. span between the centres of supporting columns, the cross girders of this span and

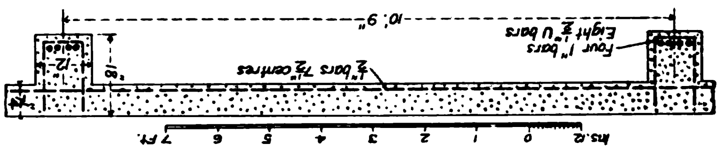


Fig. 4.

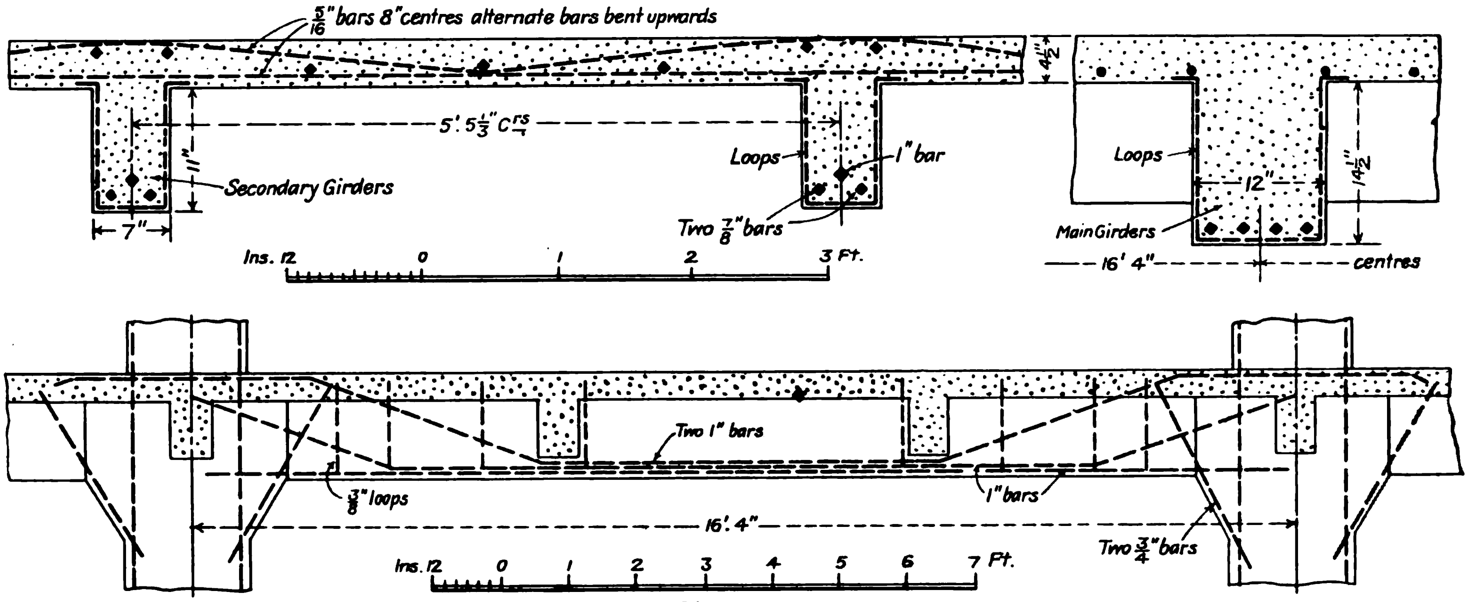


Fig. 5.

sq. in. as in the first example. In leaving off work for the day the concrete was invariably stopped at a plane at right angles to the probable plane of rupture, and all concrete was kept covered with wet tarpaulins for one or two days.

A very ingenious use of reinforced concrete has been made where upward hydrostatic pressure of ground water is anticipated under the basement floor of a building, and a case in point is that of the Power House of the United Shoe Manufacturing Co. In this case the floor underneath the rows of columns is reinforced with six 1in. bars, spliced with coils to make them continuous, arranged to form longitudinal girders to resist the upward pressure of the floor between the columns, the floor being reinforced at the top with $\frac{1}{2}$in. twisted bars 12ins. apart, and on the bottom with similar bars 6ins. apart, the edge of the floor being bonded

spaced 20ft. are 2ft. 3in. by 1ft. 2in., with five 1in. bars in the bottom and two 1in bars in the top of the girder. The longitudinal beams are spaced 3ft. 5ins. apart centres, and are reinforced by one $\frac{3}{4}$in. bar at the top and two 1in. bars at the bottom. Shearing U bars are provided for both classes of girders. The floor slabs are $3\frac{1}{4}$ins. in thickness, and are reinforced by $\frac{1}{2}$in. rods, 12ins. centres laid just above the lower surface of the slab. All the rods used in the work for reinforcement of the concrete extend beyond the panels and length of girders in each case in order to bond in with the adjacent work.

The Kahn system of hollow tile and reinforced concrete is used in the floor of the factory of the American Arithmometer Co. at Detroit, figs. 8 and 9, the span of the floors being from 16ft. to 20ft. The floor tiles are about 10ins. in depth and

12ins. width, and a 4ins. space being left between each row of hollow tiles is filled with concrete reinforced in the usual way by Kahn horizontal and inclined bars. The floor is calculated to carry a moving load of 100 lbs. per sq. ft., and the factor of safety of 4 is adopted. In the figures the peculiar and characteristic construction of the Kahn bar will be noticed. This bar consists of a horizontal bar to which inclined rods are attached for the purpose of binding the concrete together and for resisting the shearing stresses.

The Purfleet Bridge referred to in a previous article has a reinforced concrete floor consisting of cross girders, secondary or longitudinal girders under the rails, and a 5ins. slab floor. The

$\frac{1}{2}$ cubic yard of sand and 600 lbs. ($8\frac{1}{2}$ cu. ft.) of Portland cement, the whole making about 31 cu. ft. of concrete.

Expanded Metal.

The use of expanded metal has not yet been referred to, and has considerable advantages where a light but strong form of floor is required. For railway warehouses and such purposes a considerable saving of weight and cost can be effected.

Sheets of metal (usually steel) are mechanically slit and opened out by one operation, without any waste of material. In this way a trellis or net work is produced with diamond shaped meshes of a size and spacing required to be suitable for any kind of span or floor.

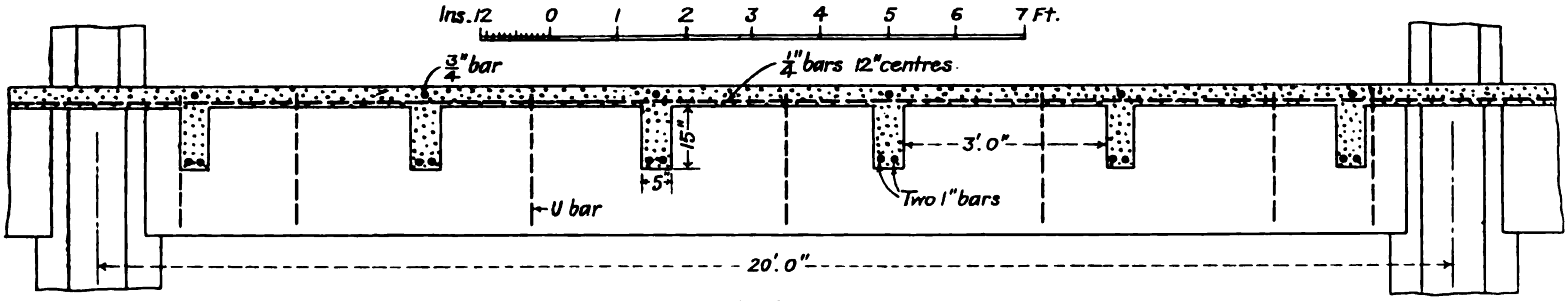


Fig. 6.

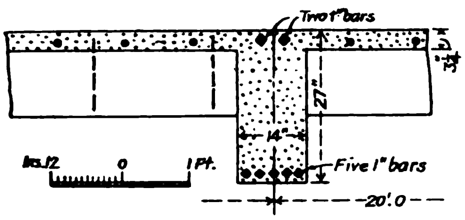


Fig. 7.

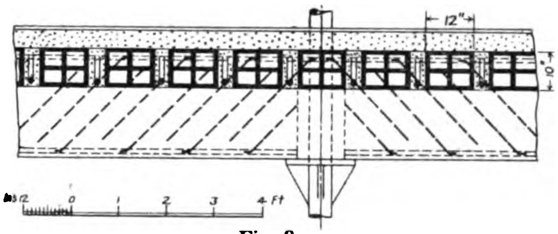


Fig. 8.

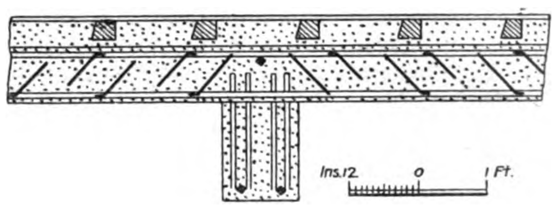


Fig. 9.

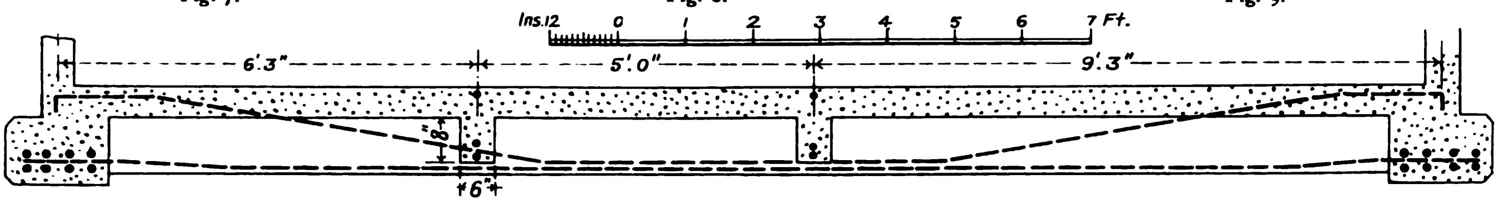


Fig. 10

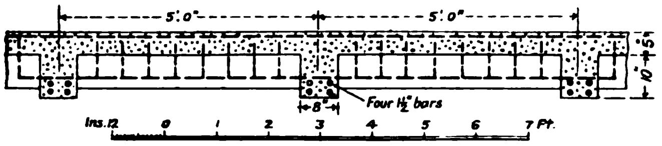


Fig. 11.

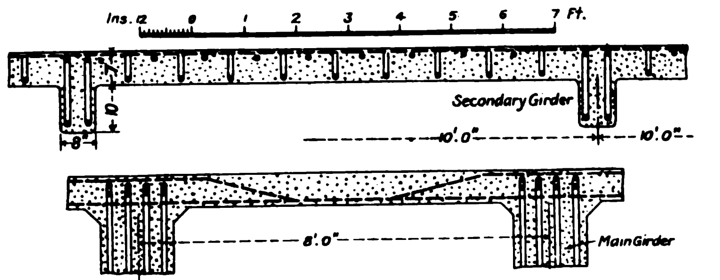


Fig. 12.

cross girders are 15ins. deep and 8ins. wide, and are spaced at distances of 5ft. centres. Reinforcing bars are placed both in the top and in the bottom of the cross girder, those in the top being carried to and having the ends hooked in to the main girder, fig. 10, the lower bars pass through the chord reinforcing bars of the main girders as shown in the figure. Sheet iron stirrups bind the material together as indicated in fig. 11. The concrete consisted of an aggregate of 4 parts broken to pass through a $\frac{3}{4}$in. mesh and 1 part Portland cement. The steel used is in round bars throughout.

The floor of the ferro-concrete bridge over the Sutton Drain at Hull rests on main girders 8ft. centres, and between these at 10ft. centres are secondary or cross girders 17ins. by 8ins., whilst a 7ins. floor as indicated in fig. 12 rests upon them. The concrete used consisted of 1 part Portland cement to 5 of aggregate, composed of 1 cubic yard of clean gravel (passed through a $\frac{3}{4}$in. mesh, but retained by a $\frac{1}{8}$in. mesh) mixed with

The thickness of metal that may be worked or opened out in this manner varies from No. 24 B.W.G. to a $\frac{1}{4}$in. thickness of plate. The stock sizes of expanded metal are from 6ft. by 2ft. to 8ft. by 2ft. 3ins., and the mesh is usually 3ins., but can be varied from $\frac{3}{4}$ins. to 6ins. The strands are usually $\frac{3}{16}$in. by $\frac{1}{8}$in. for a 3in. floor, $\frac{1}{4}$in. by $\frac{1}{8}$in. for a 4 ins. floor, and $\frac{1}{4}$in. by $\frac{3}{16}$in. to $\frac{3}{8}$in. by $\frac{3}{16}$in. for a 9ins. floor. The limiting length of the metal so treated is taken to be about 16 ft.

The amount of the reinforcing metal is usually $\frac{1}{2}$ per cent. of the sectional area of the concrete or $\frac{1}{200}$ of that volume.

When the expanded metal is embedded in the concrete slab in this way it is practically indestructible, and is not affected by damp, atmospheric conditions, and to a great extent not even by

heat. The cohesion between the metal and the concrete, aided by the peculiar shape and construction of the worked metal, is perfect. The matrix usually adopted is one of the best Portland cement to 4 of broken brick and clinker broken to pass through a ¾in. sieve, and having about 30 per cent. of clean sharp fine sand in its composition, a combination that is lighter than some other varieties of ballast concrete. The steel is usually laid about ½in. from the bottom surface of the slab.

With this form of construction a floor slab capable of carrying a load of 1½ cwts. per ft. super. can be made with a thickness of 3ins. to span a distance of 6ft., and if 7½ins. thick a distance of 15ft., or if heavier loads are to be provided for say 3 cwts. per ft. super. a floor only 3ins. in thickness will carry the load at a 4ft. distance and if 7½ins. thick to a distance of 11ft. centre to centre of supports.

The upper surface of the floor so made can be finished either by a coating of cement and sand, as granolithic, or with a layer of asphalt, according to the requirements of the case. If a wood surface is required to the floor, strips of wood or floor joists can be laid on the slab, and upon these strips the floor boards can be nailed. In other cases wooden blocks are laid directly upon the concrete slab.

One patented system of floor construction in which expanded metal is used is that of the channel arch, light steel curved channels 6ins. in width and weighing perhaps 12lbs. to the foot run being laid between rolled steel beams and having a span of anything between 12ft. to 25ft. Upon the curved channel a rib of concrete is formed up to a level surface, and upon these ribs, which may be placed at distances apart of from 4ft. to 8ft., the expanded metal floor slab is laid lengthwise, with the sides and ends overlapped. The use of the steel channel with the concrete rib or haunch upon it is claimed to be a much more economical ype of construction than those floors in which a double system of main and cross rolled steel beams are employed, and their connections at the ends of the cross beams are required. This type of floor has been used in the warehouses built for the Manchester Ship Canal Company.

In all cases where this material is adopted for floors, either in the form of rods, bars or expanded metal reinforcement, care must be taken not to infringe patent rights, which are complex and numerous.

Victorian Government Railways, 1903-4.

THE Annual Report upon the operation of the Victorian Government Railways for the year ended 30th June last is of particular interest, because it covers the first complete year since Mr. Thos. Tait was appointed Chief Commissioner, and because he has, with the co-operation of the other two Commissioners, Messrs. W. Fitzpatrick and C. Hudson, succeeded in turning a deficit of £304,094 into a surplus of £519. Mr. Tait was, it will be remembered, manager of transportation of the Canadian Pacific R., and everyone will be glad that he has been able to accomplish so remarkable an achievement in such a short time.

The main facts of the report are as under :—

The total length railways open for traffic on the 30th June was 4,264·56 miles, including 544·43 miles of sidings and 82·93 (4·56 sidings) miles of 2ft. 6ins. gauge railway. The average length open for traffic during the year was 4,250·69 miles, including 540·44 miles of sidings and 82·93 miles of 2ft. 6ins. gauge railways. The gauge of the main lines is 5ft. 3ins.

The mileage of sidings does not include 18 miles not owned by the Department, 11 miles of which are maintained by and at the expense of the Department. On the Geelong-Ballarat line 0·46 of a mile of double track was converted during the year, one line to single main track and one line to siding. The mileage for 1902-3 includes 25·22 miles which were closed for traffic during practically the whole of the year 1903-4, and are not therefore included in the mileage for that year.

The total expenditure charged to capital account at 30th June, 1904, was £41,216,703 5s. 4d., inclusive of £121,223 1s. advanced in previous years by the Treasury, yet remaining to be recouped out of revenue, an increase for the year of £242,210 6s. 2d.

The total amount of current loans allocated to the railways at 30th June, 1904, was £39,435,372 18s. 4d., an increase for the year of £464,447 5s. 6d.

The proceeds of loans allocated to the railways after deducting discounts and expenses less net premiums received, were at 30th June, 1903, £38,104,399 16s. 4d. The proceeds of the net increase during the year in the amount of current loans, viz., £464,447 5s. 6d., were only £129,010 5s. 6d., the difference, viz., £335,437, representing the discounts and expenses incurred in connection with the redemption of the loan under Act 608 allocated to the railways. The net proceeds of loans allocated to the railways were, therefore, £38,233,410 1s. 10d.

The interest paid during the year on current loans amounted to £1,496,535, and in addition the railways were debited with the sum of £20,375 to cover expenses incurred by the Treasury in connection with railway loans and interest payments, so that after deducting the sum of £1,155, which represents the interest allowed by the banks on the weekly balances at credit of railway capital funds, the net amount of the interest and expenses debited to the railways for the year was £1,515,755, which was equivalent to a rate of interest of 3·84 per cent. on the total amount of current loans.

Owing to an alteration in the dates for the payment of interest on the loan redeemed during the year under Acts 1560 and 1847, there was an exceptional increase of £23,084 in the year's interest charges and expenses.

The total amount of funds expended on the railways out of the consolidated revenue, and carrying no interest, was, at 30th June, 1904, £3,655,281 0s. 6d., of which £2,803,740 6s. 1d. was revenue derived from the sale of State lands disposed of for the purpose of providing funds for the construction of railway extensions.

The conditions which prevailed during the year 1902-3, due to the drought, the strike of engine-men, the working of the staff on short time, and percentage deductions of the salaries and wages were so extraordinary in their effect on both the gross revenue and the working expenses, that a comparison of the results of working for the year 1903-4 with those obtained in the previous year, is in many respects of but little value, and ought rather to be contrasted with those of the three previous years.*

	Year 1902-1903.	Year 1903-1904.		
Average mileage worked ...	3,335	3,371		
Train miles—suburban	2,921,280	2,616,322		
,, ,, —country	1,650,649	1,501,966		
,, ,, —mixed	2,494,280	2,166,439		
,, ,, —goods, live stock ...	3,220,063	2,887,917		
Total traffic train mileage ...	10,286,272	9,172,644		
Passenger journeys, number ...	54,798,073	54,282,003		
Goods carried, tons	2,716,827	3,182,772		
Live stock carried, tons ...	377,170	256,431		
	£	£	s.	d.
Revenue—passengers	1,325,565	1,360,483	17	4
,, —parcels, etc.	124,485	128,821	6	6
,, —horses, cars, and dogs	12,839	13,358	10	8
,, —mails	62,451	59,308	16	5
,, rents	50,890	53,651	8	3
,, —miscellaneous ...	15,858	29,538	15	9
,, —live stock	236,213	173,492	16	8
,, —goods	1,218,557	1,619,485	5	7

*For abstract of the Report for 1902-3 see *Railway Engineer* for February, 1904, and for that of Report for 1901-2 see *Railway Engineer* for February, 1903.

	£	£	s.	d.
Total gross revenue	3,046,858	3,438,140	17	2
Per mile of railways worked ...	913	1,020		
Per traffic train-mile run ...	5s. 11·09d.	7s. 5·96d.		
Ordinary Working Expenses.	£	£	s.	d.
Transportation and traffic ...	592,897	586,014	16	8
Way and works	437,840	448,958	12	7
Rolling stock—working ...	521,090	455,543	7	10
,, —repairs and renewals ...	241,625	270,342	7	6
General expenses	42,498	47,806	16	10
Total	1,835,950	1,808,666	1	5
Per mile worked	550	537	0	0
Per traffic train-mile	3s. 6·84d.	3s. 11·32d.		
Percentage of gross revenue ...	60·26	52·61		
Belated repairs—way and works	78,913	84,554	8	11
Recoups of funds advanced—				
For replacing rolling stock ...	12,217	17,146	0	0
For renewing way and works...	11,500	11,500	0	0
Total charges against wkg. exps.	1,938,580	1,921,866	10	4
Per mile of railways worked ...	581	570	0	0
Per traffic train-mile	3s. 9·23d.	4s. 2·29d.		
Percentage of gross revenue ...	63·63	55·90		
	£	£	s.	d.
Net revenue	1,108,278	1,516,274	6	10
Per mile of railways worked ...	332	450	0	0
Per traffic train-mile	2s. 1·86d.	3s. 3·67d.		
	£	£	s.	d.
Interest charges and expenses ...	1,473,532	1,515,755	0	0
Deficit	304,094†	—		
Surplus	—	519	6	10

†The deficit in the year 1902-3 is reduced by £61,160 on account of the value of services performed for the State for which no payment was received.

The gross revenue for the first half of the year was the lowest for the past 5 years, but for the last half it was the highest ever obtained. For the whole year it was £70,297 more than was earned in any previous year. Notwithstanding the very large reduction in passenger and mixed train mileage the revenue from passenger traffic exceeded the average revenue from that source during the preceding 3 years. The revenue from live stock traffic compares favourably with that of previous years except the year 1902-3, when it was largely augmented by the increased movement of live stock due to the drought which then prevailed. The increase in the revenue from goods is attributable mainly to the traffic resulting from the excellent harvest. The increase in the revenue per traffic train mile over the average of the preceding 3 years was equivalent to over 25 per cent.

Excluding belated repairs and recoups of funds, the percentage of working expenses to gross revenue was 52·61, the lowest since 1879, and if those extraordinary charges be included in the working expenses the percentage was 55·90—the lowest since 1885-6. The increase in the working expenses per traffic train mile was a natural consequence of the large reduction in train mileage and of the heavier loading of trains. In comparing the working expenses of the year with those of 1902-3, attention is directed to the fact that by percentage deductions in salaries and wages and by the staff working short time, neither of which were in effect in 1903-4, the payrolls for the previous year were reduced by, approximately, £100,000. In connection with the working expenses, it should be borne in mind that during the last few years there has been a considerable increase in the cost of railway supplies and materials—for instance, the average prices under the schedules and contracts in effect in the year 1903-4 were fully 25 per cent. higher than the average prices in the year 1896-7.

The net revenue was the largest ever obtained, and per mile of railway and per traffic train mile the highest for many years. It was £220,806 more than the net revenue for the year 1900-1—the year with the largest previous traffic—and it was equivalent to 3·84 per cent. on the railway debt.

At 30th June, 1903, the total extraordinary liabilities to be met out of revenue amounted to £795,761. These liabilities have during the year been reduced by £154,403. In addition to the extraordinary liabilities remaining at 30th June, 1904, to be met out of revenue, it will be necessary to charge a large sum to working expenses in connection with the strengthening of bridges, Flinders Street station and yard, etc. If, as they should be, these obligations are to be met out of revenue, in addition to the payment of ordinary working expenses and interest charges, it is essential that no more unprofitable lines be built, that the income be conserved by the maintenance of the existing basis of fares and rates, and that economy continue to be exercised in regard to the train and station service, as well as in every other respect.

Section 14 of the Railways Act 1439, which became law on 2nd July, 1896, reads as follows:—

"In the following cases (that is to say):—

(a) Where Parliament makes any alteration in the law which occasions any increase of expenditure by the Commissioner or any decrease of the railways revenue; or

(b) Where Parliament or the Governor in Council directs the Commissioner to carry out any system or matter of policy which occasions or results in any increase of expenditure by the Commissioner or any decrease of the railways revenue; or

(c) Where Parliament authorises the construction of any new line of railway, which, when vested in the Commissioner, does not produce sufficient revenue to cover the interest on its cost of construction and the expenses of its maintenance, the annual amount of the increase of expenditure or decrease of revenue, or of the loss resulting from such new line of railway shall be from time to time notified in writing by the Commissioner to the Commissioners of Audit, and, if certified by them, shall be provided by Parliament in the Annual Appropriation Act and paid to the Commissioner."

In accordance with a direction of the Government under this section, the then Commissioner reduced the raes on agricultural produce in December, 1899, and from that time until the year 1902-3 Parliament, in accordance with the law, provided, and the revenue of the Department was credited with, an amount equivalent to the decrease in revenue sustained by reason of such reduction in rates. In 1903 the Government decided to reduce the amount to be provided by Parliament on this account to the equivalent of one-half of such decrease in revenue, but the rates were only advanced to such extent as would make up approximately one-half of such reduction; in other words, the Department divided or bore the loss about equally with those interested in the agricultural produce traffic. Under this arrangement the sum of £48,029 has been provided by Parliament, and is included in the gross revenue for the year for the carriage of agricultural produce at reduced rates.

The re-organisation during the year of the transportation and traffic branches was productive of satisfactory results both as to efficiency and economy. The measures taken and methods adopted to cope with the heavy grain traffic resulting from the excellent harvest proved to be adequate, and it was promptly carried to the sea-board and handled there as fast as shipping was available to carry it away. The total traffic train mileage was 10·83 per cent. less than in the preceding year, and 18·72 per cent. less than in 1901-2, the year with the largest previous traffic. Although the revenue from goods and live stock traffic was over 4 per cent. greater than in 1901-2, there was a decrease in the goods train mileage as compared with the mileage of that year of 603,956 miles, and in the mixed train mileage of 776,318 miles, a total decrease of 1,380,274 miles, or 21 per cent. The increase in the goods and live stock revenue does not, however, adequately represent the increase in the ton mileage or work done by goods and mixed trains, for the additional revenue was obtained mainly from the carriage of agricultural products at comparatively low rates. This large reduction in the mileage of goods and mixed trains, notwithstanding the increase in the ton mileage and the work done by these trains, is due chiefly to methods adopted during the year for securing the heavier loading of trains and cars, and for preventing the unnecessary movement of empty trucks.

The ways and works were maintained in good working order and repair during the year. The original estimate of

the outlay required for "belated repairs" was £260,000. In the year 1902-3 the expenditure on this account was £78,913, and in the year just ended it was £84,554, a total of £163,467, leaving a balance of £96,533, but it is now considered that an additional expenditure of £78,333—a reduction of £18,200—will put the way and works in such condition that thereafter the vote for working expenses will not require to be augmented by reason of insufficient funds having been provided in the past for maintenance and renewals. The total charges were as follows:—

	£
Ordinary maintenance and renewals	448,959
Per mile* of railway	133
,, ,, track	121
For belated repairs	84,554
For recoups of funds advanced	11,500
Total charges against branch	545,013
Per mile* of railway	162
,, ,, track	147

*Average mileage open for traffic.

A considerable saving in the salaries and wages for the year was effected mainly by lengthening the roadmasters' districts and the gangers' lengths and by reductions in the force employed on maintenance. The introduction of oil motor cars for the use of repairing gangs on light traffic lines has rendered it possible to increase the gangers' lengths on the lines on which they have been put into use by about 50 per cent. Wherever it is found that it will be practicable and economical to reduce the track force by affording means to enable the gangs to travel more quickly and with less exertion over their lengths, oil motor cars, or specially constructed hand-cars, will be provided.

Of main track 102 miles were relaid during the year—7¼ miles with 100lb. rails, 69¼ miles with 80lb. rails, and 25½ miles with serviceable 60, 66, and 75lb. rails, which had been replaced with heavier rails on important lines; 273,523 sleepers were renewed and 47,142 additional sleepers were put into the track and 136 miles of fencing were rebuilt during the year: 74 interlocking levers were installed at six places, making the total number in use at 30th June, 1904, 6,533 at 493 places, and the proportion of interlocked places 60·42 per cent.: 23 sets of staff or Annett's lock gear were provided at fourteen intermediate non-staff stations. Owing to insufficient funds comparatively little progress was made during the year on the new station and yard at Flinders Street. £14,842 was expended, chiefly towards completing the subways and platforms, of which sum £5,508 was charged to capital account and £9,334 to working expenses.

The charges against the rolling stock branch were as follows:—

	£
For working	455,544
Per traffic train-mile	11·92d.
For repairs and renewals	270,342
For recoups of funds advanced	17,146
Total charges against branch	743,032
Per traffic train-mile	19·44d.

By replacements made during the year, the cost of which is included in the working expenses, the estimated amount required to make good the deficiency in the rolling stock was reduced from £403,950 to £389,000: 161 trucks were equipped with the Westinghouse brake, and 82 with brake-pipes, making the number of trucks fitted with the brake 7,991, or 80 per cent., and with brake-pipes alone 1,836: 16 cars were equipped for Pintsch gas lighting, making the total number so equipped 766, or 65 per cent.

The following new rolling stock was put into service during the year:—Locomotives: 6 of the "AA" class and 14 of the "DD" class; carriages: 2 of the "ABC" class and 2 of the "ADAD" class; steel medium trucks: 100 of 15 tons capacity and 100 of 12 tons capacity.

The construction of locomotives at the Newport shops was undertaken, and carried on during the year with decidedly satisfactory results. The first ten locomotives thus built are of the "DD" class, with a tractive power of 20,000lbs. each and weight (including tender) of 64 tons 9 cwt. They are giving good service. The cost of these locomotives, including proper provision for supervision, shop charges, and stores expenses, was £3,232 each—equivalent to £50 3s. per ton. It is confidently anticipated that even better results will be achieved with subsequent construction.

The value of the stock of stores (paid and unpaid for) at 30th June, 1904, was £501,641, as compared with £612,415 paid for and £34,588 unpaid for at 1st July, 1903, a reduction of £145,362 during the year. During the year £55,000 of £180,000 provided in the years 1896 to 1902 inclusive for the purchase of stores was repaid to Treasury.

The unproductive capital expenditure amounts to £718,540, made up as under:—

Lines closed for traffic.	Mileage.	Approx. cost. £
Dunkeld to Penshurst (dismantled) ...	15·87	50,000
Canterbury loop line (dismantled) ...	0·21	
Ashburton to Oakleigh	2·37	160,000
Fairfield Park to Deepdene	3·34	
Darling to Waverley	0·84	7,000
Lancefield to Kilmore	18·10	117,347
Coburg to Somerton	7·12	72,166
Totals	47·85	£406,513
Survey of lines not constructed... ...		312,027
Total unproductive capital expenditure...		£718,540

The amounts paid in pensions and gratuities during the year, which are not included in the working expenses, were £83,512 and £17,024 respectively, a total of £100,536, as compared with £77,775 and £15,732 respectively, a total of £93,507 in the previous year. The number of officers and employees in the service at 30th June, 1904, entitled to pension or compensation on retirement was 2,296, a reduction during the year of 253.

A revised classification of revenue and expenditure accounts, clearly providing for the allocation of receipts and disbursements to the proper accounts, became effective on 1st July, 1904.

Cattle Wagon; Midland Great Western Railway of Ireland.

We are indebted to Mr. Edward Cusack, locomotive engineer of the Midland Great Western R. of Ireland, for the annexed drawings of his standard cattle wagon, and which are so fully dimensioned as to require no further description except to say that the framing is constructed of oak.

The importance of the cattle traffic to this railway may be gauged from the facts that rather over one-third, viz., £81,772 last year, of its total goods revenue is derived from it, and that rather less than one-fourth, viz., 670, of its total goods vehicles are of the description illustrated on page 181.

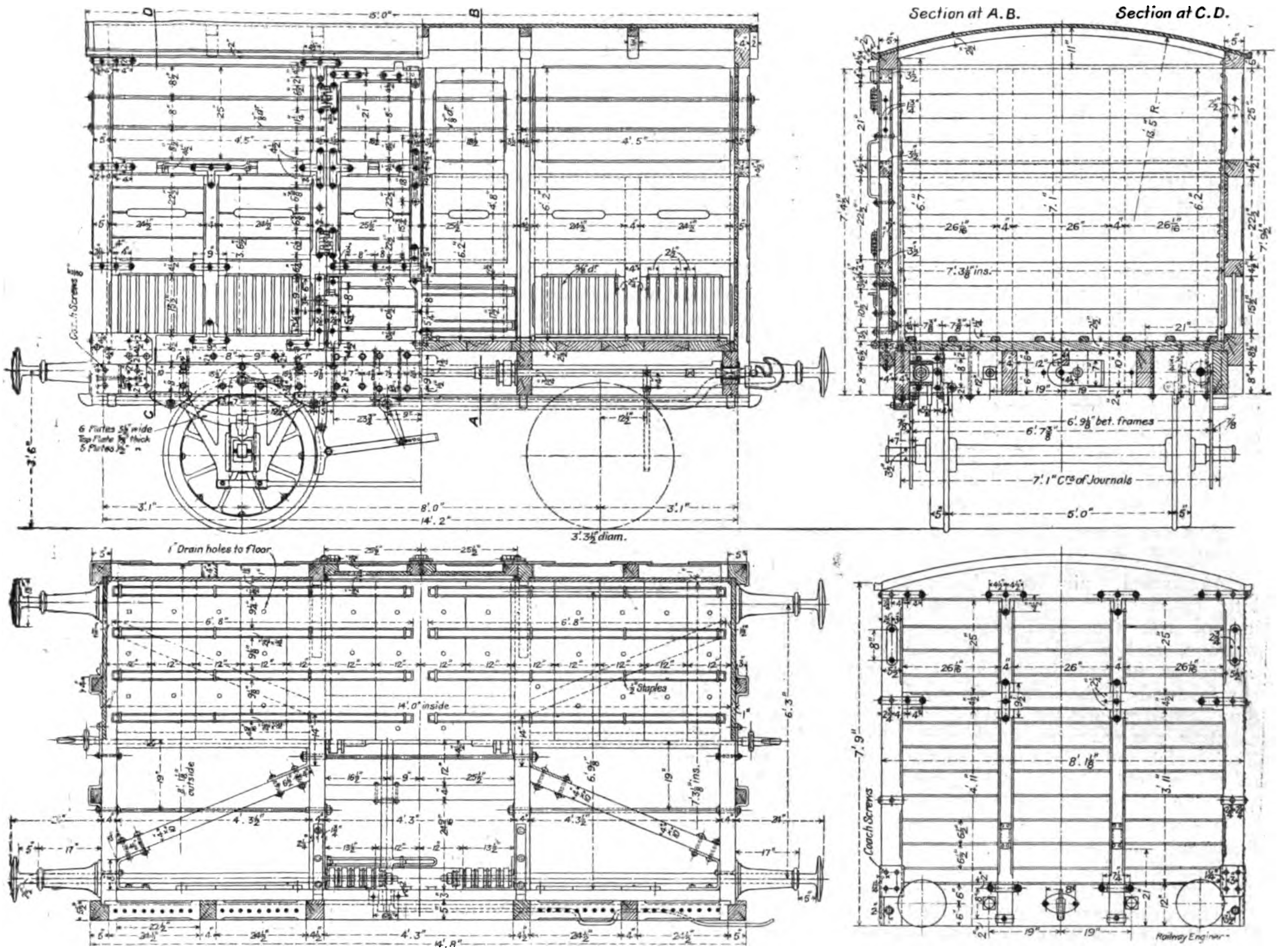
Official Reports on Recent Accidents.

Near **Crewe Station, L. & N.W.R.,** *on 20th December.*
Lieut.-Col. P. G. von Donop, R.E., reports that:—

The 12 noon train, engine and 9 vehicles, from Manchester, came into collision with a train of 9 empty vehicles, of which 5 were damaged.

The admission of up trains into Crewe Station is controlled from two signal-boxes, viz., the North Junction signal box, situated on the west side of the lines at a point 155 yards to the north of the north end of the up platform; and the Scissors Crossing box situated in the station itself at a point 85 yards to the south of the north end of the same platform.

At a point situated 190 yards to the north of the North Junction signal box there is a facing-point on the up Manchester line; the left-hand connection leads to the up loop line and the right-hand one to the up main line; from this point the up loop line and the up main line run alongside each other towards the station. The splitting signals for these two lines are situated about a yard to the north of the points; the points



Cattle Wagon.—Midland Great Western Railway of Ireland.

and signals are both worked from the North Junction signal box, the signals forming the up home signals for that box.

About 110 yards to the north of the North Junction signal-box there are facing-points on both the up loop line and the up main line; in each case the left-hand connection leads to the up loop line through the station and the right-hand connection to the up platform line. The splitting signals for these connections are fixed on two posts which stand alongside each other at a point 65 yards to the south of the North Junction signal box; both the points and the signals are worked from the Scissors Crossing signal box, and the latter form the up home signals for that box.

No confusion should arise between the pair of signals referring to the up loop line and the pair relating to the up main line; the former are not only on a different post from the latter, but they are also different in shape, the arms being provided with rings.

The trailing connection on the up loop line through which the empty coaches were being shunted is situated 56 yards to the south of the Scissors Crossing box home signals for the up loop line.

Ordinary block working is employed between the Sydney Bridge and the North Junction signal boxes, but between the latter box and the Scissors Crossing box station yard working is in force, and the method of working is as follows:—

There are in the North Junction signal-box several mechanical discs, each disc referring to one of the lines through Crewe Station. These discs, which are worked from the Scissors Crossing box, show the signalman in the North Junction box whether the line in the station to which each refers is clear or not.

When a train is approaching the North Junction signal box the signalman in that box offers it to the signalman in the Scissors Crossing box; the latter acknowledges the receipt of the message and indicates on his instrument the station-line on which he wishes the train to run; if that line is clear up to the south end of the station, he also turns up the mechanical disc in the North Junction signal-box relating to that line, but if it is not clear he does not do so.

If the mechanical disc is turned up the signalman at the North Junction box is authorised to lower his home signal for the train to run past it; but, if the disc is not turned up, he is not permitted to do so until the train has come to a stand at his home signal; when the train has come to a dead stand at his home signal, the signalman may then lower it, thus signifying to the driver that he may draw up to the Scissors Crossing home signal.

Driver Cooper states that his train was stopped at the North Junction up home signals, and as soon as it had come to a dead stand the up loop line home signal was lowered for him. Cooper states that he thoroughly understood from this that the station-line was not clear for his train, but that he had permission to draw up to the Scissors Crossing home signals; he accordingly drew up his train along the up loop line at a low rate of speed, intending to stop at those signals.

On approaching the Scissors Crossing home signals, however, Cooper saw that the signal was lowered for a train to run from the up main line to the up platform line. This signal

had been lowered for a train from the Liverpool direction which was about to run into the station from the up main line. Cooper fully admits that for the moment he forgot that his own train was running on the up loop line, and, under the impression that it was running on the up main line, he thought that the signal which was lowered had been lowered for himself; instead, therefore, of bringing his train to a stand at this point, he allowed it to run on along the up loop line and consequently came into collision with the empty coaches which were at that moment being shunted out of the up loop line.

Cooper admits that he is entirely responsible for this collision; he acknowledges that both the signals referring to the up loop line on which he was running were at danger when he passed them, and that the collision was entirely due to the momentary mistake which he made of thinking that he was running on the main line. This mistake on Cooper's part appears to have been the sole cause of this accident.

Cooper has been in the service of the Company for 28 years, and he bears a most excellent character; at the time of the accident he had been on duty about 6 hours.

*

At **Carn Parc, T.Y.R.,** *on 7th December. Lt.-Col. E. Druitt, R.E., reports that:—*

A mineral train from Aberdare to Treforest was run into by another mineral train (from Merthyr), consisting of two 6-coupled engines, 54 loaded and 5 empty wagons, and a 10½-ton van, and which had got out of control on the main incline above Abercynon Station and had run forward on the down mineral line to Carn Parc. A fireman, a driver, and the brakesman of this train were injured.

Both engines were fitted with steam and hand brakes. Their combined weight was 124 tons, of which 100 tons were on the braked wheels. The train weighed about 850 tons, and was about 400 yards in length. The engines of this train were disabled, and 23 wagons of the two trains damaged, 10 of them badly.

Carn Parc is 417 yards south of Abercynon south box. The next box to the southward is Stormstown.

The gradients between Tunnel Quarry signal box and Carn Parc on the down line are :—Tunnel Quarry box to incline top, 300 yards falling 1 in 334, 2,000 yards falling 1 in 40, 525 yards falling 1 in 1,538; and thence to Carn Parc and Stormstown signal boxes 1 in 259 falling.

The authorised speed down this bank is 8 miles per hour. There is a rule to the effect that before a mineral train is allowed to leave Tunnel Quarry signal-box "Line clear" has to be obtained as far as Carn Parc home signals.

The Merthyr train left Tunnel Quarry signal-box about 7.21 p.m. It drew ahead to the down starting signal and white post alongside marking the top of the 1 in 40 incline, and there stopped. When the guard and brakesman had walked forward to the head of the train they called the banksman, who is always on duty at the incline top, to assist in putting down the wagon brakes, and as soon as they were ready to start doing so the guard told the driver to proceed. As the brake levers of the wagons were mostly on the six-foot side, all three men worked on that side of the train and used brake sticks.

When a few wagons—8 to 12, all braked—were over the top incline, driver Foakes, of the leading engine, who was in charge of the train, states he could hardly move it, so he signalled by whistle to the driver of the second engine to put on steam, which he did for a short distance. Finding the train was then travelling too freely, Foakes shut off steam on his engine and signalled for the driver of the second engine to do so.

Foakes estimates that there were 30 or 40 wagons on the incline at this time, and that then he partially applied the steam brakes in order to feel the weight of the train, but finding it running too easily he applied the brakes fully and opened both sanders. When his engine was about half-way down the incline Foakes whistled for the second engine to apply brakes, which signal was replied to, but the speed was not checked but increased to the foot of the incline, and the train ran forward on the down mineral line to Carn Parc, where it collided with another mineral train crossing from the main to the mineral line, the point of collision being 770 yards from the foot of the incline and 200 yards beyond where the leading engine of the train would have stopped had the train been brought to a stand just inside the trap points of the down mineral line at Abercynon North signal-box.

The men putting down the brakes state that the train went slowly at first, but that after they heard the whistle for the second engine to put on steam the speed increased and continued to do so, and in consequence they were only able to pin down the brakes on 15 to 20 wagons before the speed was too great for any more to be worked. The guard and brakesman then ran back to meet their van, and got into it just before it reached the incline top, and immediately put on the hand brake as hard as possible. They estimate the speed of the train as 15 miles an hour when the brake van got to the incline top, and the signalman at Abercynon South box, beyond the bottom of the incline, as 30 to 35 miles an hour when it passed his box.

No communication passed between driver Foakes and guard Lewis as to how many brakes were required to be applied. Driver Foakes states he could not give this information, as it is impossible to say (until the driver feels the weight of the train after commencing to descend the incline) how many brakes will be required to be applied, and guard Lewis stated he could not have put more brakes down than he and the other men did, had he been told that any given number, such as 30, were required. On this occasion the fireman of the banking (leading) engine ascertained from the driver of the train engine the number of wagons on the train, and told driver Foakes, who was thus acquainted with the load. The Co. lay stress on the special rules being carried out, and intend that the guard should inform the driver of the banking engine (which is only coupled on at the incline top) of the nature of the wagons composing the train and their brakes, as with various types of wagons and brakes a different number of wagons has to be braked.

The following points arise in connection with this accident which require mentioning :

1. The practice of crossing trains from the down main to the mineral line at Carn Parc and thus obstructing the down mineral line 140 yards ahead of the home signal after permission has been given to a heavy mineral train to leave the top of the incline. Looking at the length of the train in question, viz., 400 yards, and seeing that it was expected to run on to the down mineral line at Abercynon North box, clear of the trap points, in order to allow a passenger train to follow it at once, it follows that owing to the distance between these trap points and Carn Parc home signal being only 617 yards, there is only a margin of about 200 yards for an over-run between the head of the train and the home signal. The points of the crossing in the mineral line are 140 yards beyond this signal. On the occasion of the collision, signalman Davis at Carn Parc accepted the Merthyr train (down the incline) at 7.20 p.m., and the Aberdare Branch train at 7.29 p.m., and when the latter arrived at his home signal at 7.37 p.m. he at once allowed it to cross on to the down mineral line, and it was still crossing when run into by the Merthyr train. Looking at the short distance for a train from the incline to over-run before fouling the crossing the signalman at Carn Parc, after accepting a train down the incline, should not allow any thing to cross on to the mineral line until he knows the train from the incline has come to a stand in Abercynon yard. Signalman Davis is not to blame, as he carried out the usual practice.

2. The line at the top of the incline was formerly in a tunnel, and this has been opened out, but there are high retaining walls and a high bank above the walls, rendering the spot where brakes have to be applied to the wagons of a mineral train very dark. It was pointed out that the process of applying brakes would be rendered easier if powerful lights were provided on the top of the retaining walls on each side of the line, as it would leave the hand now required for hold-

ing a lamp free for holding the brake stick, and the other free for inserting the pin to hold down the brake lever. As the safety of the trains descending the incline depends on a sufficient number of brakes being applied, the Co. should consider the advisability of providing lamps for lighting this place.

3. The question of liability of pin brakes to become released from the pins working loose when the wagons are jolted on the incline, was also raised, but owing to the first 20 wagons of the train in question being smashed up by the collision it was not possible to ascertain if any had worked loose on this occasion and by so doing diminished the brake power at the driver's command.

4. With regard to No. 13 of the "General Rules for working trains over steep inclines," guard Lewis states he was unable to get out of his van to put down more brakes when he found the train was out of control, because, owing to the nature of the wagons next his van and the high speed, he would have been unable to put in the pins to secure the brakes. This rule, though only occasionally acted upon, is not a satisfactory one; guards should not be expected to ride anywhere on the train except in the brake van, and should not be expected to climb over the wagons to put down more brakes while running. The Co. should consider the advisability of using heavier brake vans, and so place greater braking power at the disposal of the guard riding in the van.

*

Between **Athlone and Moate, M.G.W.R. of I.,** *on 14th January. Lt.-Col. P. G. von Donop, R.E., reports that:—*

A special cattle-train (engine, tender, 36 wagons and a guard's van), travelling from Athlone towards Moate, was run into from the rear by a special inspection train. Two drovers and the guard were injured.

The line where the collision occurred is level, but it is at the top of a rising gradient of 1 in 150, 2 miles long. It is on a left-hand curve 120 chains radius. The block section extends from the East Junction signal-box, Athlone, to the Moate signal-box, a length of about 10 miles. Athlone East Junction signal-box is provided with home, starting and distant signals; the home signal is situated 17 yards to the west of the signal-box, and the starting signal 385 yards to the east of the box.

At 4.25 p.m. signalman Staunton, who was on duty in the East Junction signal-box, was offered the engineer's special up train from the West Junction signal-box; he at once accepted it, keeping all his signals at danger. The train approached his home signal at 4.30 p.m., and when Staunton saw that it was going at a low rate of speed he lowered his home signal and went to the window with a green flag. He states that the driver brought the train up to the box at a walking pace, and that he himself then gave the driver verbal instructions to proceed to the starting signal, which was at danger, as the section in advance was still occupied by the catle train. Driver Carroll, who was in charge of the engine of the engineer's special train, denies receiving any verbal instructions from him, but he admits that the starting signal was at danger, and he states that he therefore only allowed his train to run up towards it at a low rate of speed.

When approaching the signal-box at the 73rd mile, Carroll states that he suddenly caught sight of the corner of the van of a train in front of him. He estimates that at this time he was about 100 yards from that vehicle and that his train was going at a speed of about 35 miles an hour. He turned off steam, applied his brakes and reversed his engine, but he was unable to bring his train to a stand in time to avert the collision.

Signalman Staunton states positively that his starting signal was never lowered at all for the engineer's special train, and the balance of evidence therefore supports his statement; therefore the responsibility for this accident must rest mainly on driver Carroll for running past that signal at danger. He has an excellent character and had been on duty just under 10 hours.

This curve undoubtedly interfered with the view of Carroll, but it did not interfere to the same extent with that of fireman Rapple, who was on the left side of the foot-plate. An examination on the spot showed that it was possible for Rapple to have seen the van in front of him when at a distance of over 300 yards from it. Therefore, that if Rapple had been keeping a good look-out he would have seen the cattle train in time to have allowed of his own train being brought to a stand before coming into collision with it.

*

Between **Howden and Wressle, N.E.R.,** *on 17th January. Lt.-Col. P.G. von Donop, R.E., reports that:—*

The 2.20 a.m. special goods-train (Hull to York), consisting of an engine, 60 wagons and a brake van, was run into by the 2.40 a.m. up mineral train from Hull to Peckfield Colliery, consisting of an engine, tender, 70 empty coal wagons, 4 oil tanks, and a brake van, at a speed of probably between 15 and 20 miles an hour, and the damage done to rolling stock was considerable. One guard was killed, and the other injured.

Howden and Wressle stations, on the Hull and Selby branch of the N.E. R. are 2 miles 1,740 yards apart. The up-line is on the south. Howden signal-box is provided with the usual distant, home and starting up signals, the latter being situated at a point 509 yards to the west of the signal-box. The collision occurred at a point one mile 90 yards to the west of the Howden signal-box, that is, 1,341 yards ahead of the Howden up starting signal.

The goods train had been duly offered to, and accepted by, the signalman in the Wressle signal-box, and it had passed the Howden signal-box at 3.41 a.m. Driver Turpin, of the goods train, states that soon after he had passed the Howden starting signal his injectors broke down and he had to bring his train to a stand, at 3.45 a.m., with its rear end 1 m. 90 yds. beyond the Howden signal-box. Guard Smith came up to the engine to ascertain what had happened. The driver succeeded in getting one injector to work, so he decided that the best course to adopt would be to run back to Howden and put his train into the sidings there clear of the main line. Turpin arranged that his fireman, Dunham, should walk back to the Howden signal-box to obtain a wrong line order form, and that guard Smith should meanwhile protect the rear of the train. Dunham and Smith both walked back to the rear of the train, but, as they were walking on different sides of it, they did not have any conversation together, and all that Dunham can say with regard to Smith is that he saw him a short distance behind him when he himself reached the brake van. Dunham walked on towards the signal-box, and when close to the down distant signal, situated at a distance of 820 yards from the Howden box, *i.e.*, 1,030 yards from the rear of his own train, he saw the mineral train approaching. He states that he at once showed a red light and shouted to attract the driver's attention, but he does not think that either the driver or fireman saw or heard him.

Driver Took, who was in charge of the engine of the mineral train, states that when he approached Howden all the signals were off for him, so he ran past them without checking, at a speed which he estimates at about 20 miles an hour. When he was about 50 yards from the van of the goods train he saw the light of it, so he at once applied his brakes and turned off steam, but he was unable to stop his train in time to avert the collision. He attributes his not having seen the lights sooner to the fog which prevailed at the time. Both he and the fireman state that they did not run over any detonators after passing the Howden signal-box.

Signalman Pool was on duty at the time in the Howden signal-box, and signalman Firth was on duty in the Wressle box. Firth made the mistake of giving the "Train out of section" signal for the goods train whilst it was still in the section, and the responsibility for this accident consequently

rests primarily on him. Pool must, however, be held largely responsible for it. He duly received a message from Firth asking him to stop the train when the engine was only about 50 yards beyond his box; it was, therefore, still at a distance of about 450 yards from the starting signal, and there was ample time for Pool to have put that signal to danger. The only reason which Pool can give for not having done so is that Firth had not sent him the proper "Obstruction danger" signal. This was undoubtedly the case, but it in no way justified Pool in refusing to take action on such an important request as Firth had made. His neglect to do so is inexplicable.

It is clear that the rear of the goods train was not protected at all by detonators placed on the line. Smith was still in his van when the collision occurred and was killed.

*

Near **Hull Station, N.E.R.,** *on 31st January. Lt.-Col. P. G. von Donop, R.E., reports that:—*

The 5.17 p.m. passenger train, Scarborough to Hull (engine, tender and 4 vehicles), ran into a light tank-engine which was running on the same line in the facing direction; 9 passengers complained of injuries. Both engines were very severely damaged.

Driver Kitching, of the light engine, corroborates the evidence of the signalmen. He states that the signals were duly lowered for him to run up to the up home signal of the Park Street box, and that he brought his engine to a stand at that signal; the signalman then gave him a white light, and shouted "Right for the loco.," so, after a short delay caused by a difficulty in getting his engine to move, he set his engine back to run to the locomotive sheds. There is, however, no doubt that the light engine did not set back along the "B" road beyond No. 15 points, but that it ran through these points along the "A" road, thus running back in the facing direction towards the West Parade box, on the same road on which it had come forward. When approaching that signal-box, driver Kitching suddenly observed that he was on the wrong road. He at once shut off steam and applied the brakes, but his engine burst the connection No. 52 between the "A" road and the up line, and, just as it was coming to rest under the Argyle Street bridge, it came into direct collision with the engine of the Scarborough train, which was approaching the station on the up line.

This collision was due to the fact of the light engine having run back through No. 15 points from the "B" line on to the "A" line instead of continuing back along the "B" line and thence along the connection leading to the engine sheds.

The result was probably due to one of two causes—either the light engine had not passed through No. 15 points at the time that they were set for the "B" road, or the points were never set for that road at all.

The most probable cause of this accident was that No. 15 points were not restored by signalman Moverley until after the light engine had run through them, and that the light engine consequently took the wrong road at those points. To signalman Moverley's mistake this accident must therefore be attributed.

Driver Kitching should have discovered sooner than he did that his engine was on the wrong road. Kitching states that the reason he did not discover this sooner was that he was getting his kit ready to go home; had he been keeping a good look out instead this collision might have been averted.

The only other point to which attention need be called is the absence of a fixed signal for the operation of running from the "A" road to the down shed line. Had a fixed signal, properly interlocked with the points, been provided for this movement this collision would not have occurred. Doubtless the use of this movement was not anticipated when the signalling arrangements were installed; if, however, the Co. finds that this movement is a necessary one a fixed signal should certainly be provided for it.

*

Near **Monkseaton, N.E.R.,** *on 20th February. Lt.-Col. P. G. von Donop, R.E., reports that:—*

At about 2 p.m. on 20th February, Elizabeth Chapman, aged 13, was found lying across the line near Earsdon Grange signal-box, and she had evidently met with her death by coming into contact with the live rail which is used in connection with the electric train service recently installed between Newcastle and Monkseaton.

The line is double. Each line is provided with a "live" rail for electrical working, these two live rails being both situated in the six-foot way; each of these "live" rails is fixed at a lateral distance of 19ins. from the nearer rail of the line which it serves, and the upper surfaces of the live rails are 3¼ins. above those of the running rails. The live rails carry a current the potential of which is 550 volts. There is on the south side of the railway a village called New York, distant about a mile from the line, and on the north side of the railway there is a farm, known as Earsdon Grange, distant about 100 yards north of the spot on the line where the deceased was found lying. The deceased lived in the village of New York and had been employed at Earsdon Grange; on the day in question there seems no doubt that she was going from the village to the Grange. There is a public footpath leading from the direction of the New York village up to the railway line; the direction of this footpath for the last 200 yards before reaching the line is north-west, and it crosses the line about 100 yards to the west of Earsdon Grange, it then bends towards the north-east and joins a main road just to the westward of the Grange. At this public footpath level crossing the electrical current is carried under-ground by means of a cable, and where the live rails terminate on each side of the crossing they are guarded by wood casing for a length of 12ft. At a point situated 60 yards to the east of this public footpath level crossing there is an occupation crossing for the use of Earsdon Grange; the gates of this occupation crossing, which opens into fields on each side of the line, are kept locked, and the crossing is protected precisely similarly to the footpath one described above. The occupation crossing being nearer Earsdon Grange than the footpath one, forms a short cut from the public footpath to the Grange; on this account it is evidently customary for pedestrians, who wish to get to the Grange from the south side of the line, to leave the public footpath before reaching the line and to make use of the occupation crossing, climbing the gate or the fence alongside of it. The spot where the deceased was found was situated 18 yards to the east of the occupation crossing. There is a signal-box on the south side of the line situated 160 yards to the east of the spot where the deceased was found, and it was from this box that she was seen lying on the line by signalman Johnston, who was on duty at the time in that box. The line in the neighbourhood of the spot where the accident occurred is enclosed by a fence 4ft. in height, consisting of wooden posts and rails; it is a substantial fence, but one which can easily be climbed.

There are two recognised level crossings by which access is gained between Earsdon Grange and the south side of the line, and that at both these crossings efficient safeguards are provided to prevent pedestrians from coming into contact with the live rail. I consider that reasonable facilities are provided to enable the public to cross the line in safety, and that further guarding of the live rail at other points in this neighbourhood seems hardly to be called for.

It was noted, however, that though a notice board warning people of the danger of the live rail had been erected at the public footpath level crossing, no such board had been provided at the occupation crossing, though this has since been fixed.

EDITOR'S NOTICE.—All manuscripts and communications should be distinctly written, or preferably type-written, on one side of the paper only, and addressed to the Editor, **3, Ludgate Circus Buildings, London, E.C.** The Editor cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped directed envelope.

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THE Railway Engineer

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Contents for July.

Sir Walter Plummer, M.P., and **Dr. Roland Philipson** have been elected directors of the North-Eastern R.

The Rt. Hon. Lord George Hamilton and **Mr. Wm. H. Brown** have been elected directors of the Metropolitan District R.

Mr. W. M. Acworth has been elected a director of the Midland and South-Western Junction R.

Mr. Wm. Guy Granet, secretary of the Railway Companies' Association, has been appointed assistant general manager of the Midland R. in succession to **Mr. E. W. Wells**, who resigned on account of failing health. Mr. Granet was educated at Rugby and Oxford, and was called to the Bar in 1893. He was appointed secretary of the Railway Companies' Association in 1900 when Sir Henry Oakley gave up the honorary secretaryship.

Mr. Wm. Andrew, assistant chief goods manager for the North British R., has been appointed chief goods manager in succession to **Mr. A. Rutherford**, who has retired after a service extending over 54 years.

Sir John Wolfe Barry, K.C.B., F.R.S., has been unanimously elected to succeed the late **Mr. James Mansergh, F.R.S.,** past president of the Institution of Civil Engineers, as chairman of the Engineering Standards Committee, which post Mr. Mansergh had occupied since the formation of the committee in 1901.

The "Limited" Express Trains between London and Penzance.

WITH this month the Great Western R. Co. put on for the summer season the "Limited" express trains between Paddington and Penzance in both directions. Mr. Churchward has designed and built at Swindon three new and beautifully fitted trains for the service, the chief feature of which will be, as last year, that the trains run between Paddington and Plymouth without stopping. The complete journey is made in 7 hours. The carriages have several novel features to which we shall refer more fully when we publish the drawings of one of them. The carrying capacity of the trains has been largely increased without much increasing the tare weight by widening the carriages to 9ft. 6ins. at the waist and thus seating 3 a side in the first and 4 a side in the third class. There is no second class this year. The cross section of the carriages is uniform with the dining saloon and has the high curved roof in place of the clerestory. The corridor crosses at the middle from one side of the carriage to the other, an arrangement which provides "outside" corner seats on both sides, balances the vehicle, and should tend towards steadier riding. The trains are equipped with electric light and the Lucas-Leitner system has been adopted. The seats are numbered, and are reserved upon payment of a fee of 1s.

*

Lancashire and Yorkshire Railway; New Service from Goole to Bruges.

THE opening of the new ship canal from Heyst (Zeebruggee) last month by the Lancashire & Yorkshire R. Co.'s steamer "Mellifont" is an important event, because it indicates that the ship canal from Heyst to Brussels is nearing completion. The Heyst-Bruges section is straight and about 7 miles long, and quite supercedes the canal from Ostend to Bruges, which is more than twice the length and not straight.

From Bruges to Brussels extensive works are in progress, and docks and warehouses on a large scale are making rapid progress at Brussels. The construction works of this canal are very interesting, more particularly when one remembers our own fiascos at Manchester.

The Lancashire and Yorkshire R. Co. will now maintain a regular service to Bruges, and will increase its frequency in accordance with traffic requirements.

*

Baldwin-Westinghouse Electric Locomotive.

DURING the visit of the delegates to the International Railway Congress at the Westinghouse works at Pittsburg a great deal of interest was attracted to the new 1500h.p. Baldwin-Westinghouse single-phase alternating-current electric locomotive in use on the Westinghouse Interworks R. This locomotive had just been completed by the Westinghouse Co. and the Baldwin Locomotive Works, and is in two parts, connected and controlled by the unit-switch system. The weight of the locomotive complete (both halves) is 135 tons, and the total length over buffers is 45ft. The maximum height with trolley down is 17ft. The diameter of the driving wheels is 5ft., and the distance between their centres is 6ft. 4ins. The extreme width of the locomotive is 9ft. 8ins.

The locomotive is equipped with six single-phase, single-reduction motors, having a normal capacity of 225h.p. each, with gear reduction of 18 : 05. Induction regulator control is used with a pneumatically-operated trolley. It is equipped with the combined automatic and straight air brake and with pneumatic sanders to sand the tracks in both directions. It is designed to

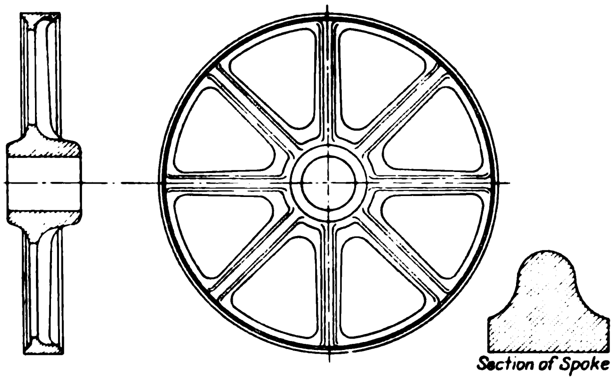
operate on 6,600 volts trolley voltage, with a voltage of 140 to 320 on the motors, and has a draw-bar pull of 50,000 lbs. at a speed of approximately 25 m.p.h. to 30 m.p.h.

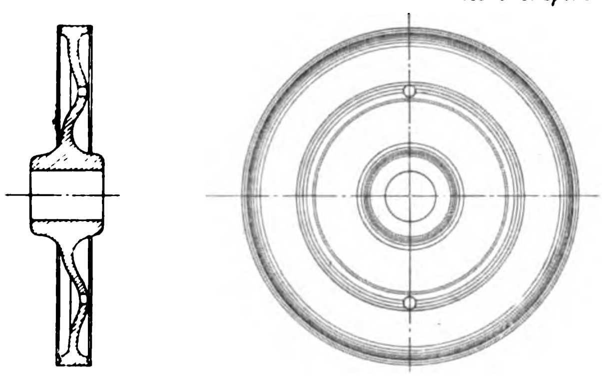
*

The "Brunswick" Patent Weldless Steel Wheels.

THE Patent Shaft and Axletree Co., Ltd., of Wednesbury, are now putting on the market the "Brunswick" Weldless Steel Wheels of both the disc and spoke patterns as shown in the illustrations, and of which they are the sole makers. These wheels are made from solid steel ingots, and are made thoroughly homogeneous by a process of forging and welding to any required dimensions and of any reasonable degree of hardness and ductility.

They are equally suited for use under tenders, carriages or wagons. The spoked pattern is lighter than either a built up wrought iron or a cast centre. The following record of a test shows that these wheels are very strong.





A centre, 33ins. diameter, was tested by Messrs. D. Kirkaldy and Sons with a one-ton tup falling 9ft. It was subjected to eight blows falling on the rim directly over a spoke, and was reversed after the fourth blow. After the 4th blow two spokes went slightly buckled, and after the 8th blow a hair crack was started and the flattening was 3·38ins. It afterwards required six more blows on the rim midway between the spokes to destroy it. As the tendency at the present time is towards a stronger wheel centre in order to meet the continually increasing strains due to the use of high speed, continuous brakes and heavier axle loads, the "Brunswick" weldless steel wheel should be welcomed by engineers in charge of rolling stock.

*

Peihan Railway, China.

ACCORDING to a Reuter telegram the first locomotive, drawing an inspection train with the chief engineer of the Peihan R. on board, crossed the Yellow River bridge (3,200 yards long) on the 11th ultimo. The line, it is expected, will be opened to general traffic in November next.

Cape to Cairo Railway.

AT the beginning of last month the British South Africa Co. announced that the contractors, Messrs. Pauling and Co., for the extension of the Cape to Cairo R. beyond the Victoria Falls, had received information from Africa that the railway and telegraph lines had reached Kalomo, the headquarters of the North Western Rhodesia Administration, 90 miles north of the Zambesi Bridge. The construction of the 250 miles to the Rhodesia Broken Hill will be proceeded with immediately, and much of it built at the rate of a mile a day.

The Zambesi Bridge, which was linked up on the 1st of April, was to be completely rivetted, painted and finished by the middle of June, but it is interesting to note that 50 miles of railway north of the Falls were constructed before the material could be taken across the bridge, the locomotives, trucks, rails, sleepers and other necessaries being carried across the gorge by means of the electric transporter.

*

Italian Single-phase Electric Railways.

THE French Westinghouse Co. have, we understand, recently secured the contract for the installation of the Westinghouse single-phase system on the Bergama, Valle Brembana R., Italy.

The length of the line will be 30 *kiloms.*, and the gauge 1·44 *m.* It will be worked by five 30-ton locomotives equipped with four 75-h.p. Westinghouse single-phase motors, multiple unit control, and pneumatically-operated bow trolleys. The power station is to be situated about 1 *km.* out of Valle Brembana, and will be equipped with three single-phase 500 KW. Westinghouse alternators, running at a speed of 500 r.p.m. There are to be no transforming sub-stations, and the line will be fed at the above pressure direct from the power house.

This is the second single-phase railway contract in Italy entrusted to the French Westinghouse Co., as they had already secured the contract for the Rome-Civita-Castellana R.

*

Incandescent Gas Lighting for Railway Trains.

AT the last annual meeting of the Institution of Gas Engineers, Mr. E. C. Riley, gas assistant of the locomotive department of the G.W.R., Swindon, read a paper upon incandescent gas lighting for railway trains, and in the course of which he gave the following interesting particulars of the experiments carried out upon the Great Western R.:—

"After the questions of vibration and fixing had been decided, "those relating to ventilation of the lamp, prevention of draught "while securing an adequate supply of air, prevention of injury to "the bunsen flame and consequent loss of illuminating power by "the presence of small particles of dust or carbon in the fine gas- "passage in the nipple arose, and received attention. The "experiments were all conducted with the aim of utilising the "existing carriage roof lamp, so as to avoid the expense of making "or purchasing new lamps. The carriage first used for experiment "was of an old type which was known to give least room, and "offered most difficulty in carrying out the necessary alterations. "After several trials, it was found possible to secure a good, steady "light, with the advantage of a saving of two-thirds of the gas "previously used; but as one of the objects was improvement of the "lighting, the actual results were that a light of 20 candles was "obtained with the incandescent burner with a consumption of 0·65 "cub. ft. of gas, as against a light of 13·5 candles with 1·5 cub. ft. "by the old method. When the questions of illuminating power, "consumption, and steadiness had been satisfactorily dealt with, "considerations with regard to mantle endurance had to be taken "into account. For this purpose the carriage, fitted with incan- "descent burners throughout, was run regularly on a train for a "month between Swindon and Cardiff, with the result that in the

" month's running, covering a total of 5,567 miles, it was only "necessary to renew one mantle. After this, a large corridor coach, "with lavatories, &c., was fitted. This coach ran for a month, and "travelled 4,464 miles; and again one mantle only had to be "renewed. This was satisfactory, as it compared favourably "with French results which were obtained over a longer period. "This carriage is still running, and the latest figures show that in "14 weeks' continuous working, running 15,624 miles, only seven "mantles had to be renewed in the nine lamps."

Mr. Riley appears to have approached the subject "without any knowledge of French applications" which had been going on for some years, and the results of which were published widely in this country in the autumn of 1903. The chief, or one of the chief, facts discovered, after much trial and tribulation, by the French engineers was that anti-vibration fittings are useless on railway carriages. Mr. Riley arrived at exactly the same results after making

"a series of experiments to ascertain how the effects of vibration "during the time the train was running, or the carriages were "being shunted, might be counteracted. For some of these anti-"vibration arrangements provisional patent protection was "obtained; but after many alterations and experiments—in each "case tested by the effect of running on a train—all anti-vibra-"tion devices of every kind were discarded, and a rigid connec-"tion of the burner on to the gas-supply pipe was adopted."

This is a curious instance of engineers working independently of each other with the same object in view and arriving at precisely the same result. Mr. Riley also stated that some trouble that had been experienced with the gas lights on the rail-motor cars of the G.W.R., owing to the extra vibration caused by the engine, had been quite cured by the use of incandescent mantles.

"The experiment was made on a wet, stormy day, and "the car was run at a high speed through a tunnel and along an "exposed embankment. But the lights continued perfectly "steady and satisfactory. The consumption of mantles has been "two for the 12 lamps in five weeks, during which time the car "has run 2,928 miles. The effect in the rail motor, owing to the "car being open throughout and not divided into compartments, "is more brilliant and pleasing even than in the ordinary "carriage. The lights assist each other; and the appearance of "the row of lamps from either end is very striking and "attractive."

Light Railways in Belgium.

WE have frequently drawn attention to the successful operation of the *Soc. Nationale des Chemins de fer Vicinaux*, which controls all the light or feeder railways in Belgium.

During last year this company obtained concessions for 19 new lines, of an aggregate length of 373·3 kiloms., making the total number of lines conceded 139 and their length 3,430·5 kiloms. Of these lines 115, having a length of 2,500 kiloms., are in operation, and which is equal to nearly 5 kilos. per 10,000 inhabitants, or 11·6 kiloms. per 10,000 hectares. About 477 kiloms. are 3ft. 6in. in gauge, only 37·3 normal gauge and the rest metre gauge. Of the lines open to traffic 2,398 kiloms. are worked by steam and 97 kiloms. by electricity.

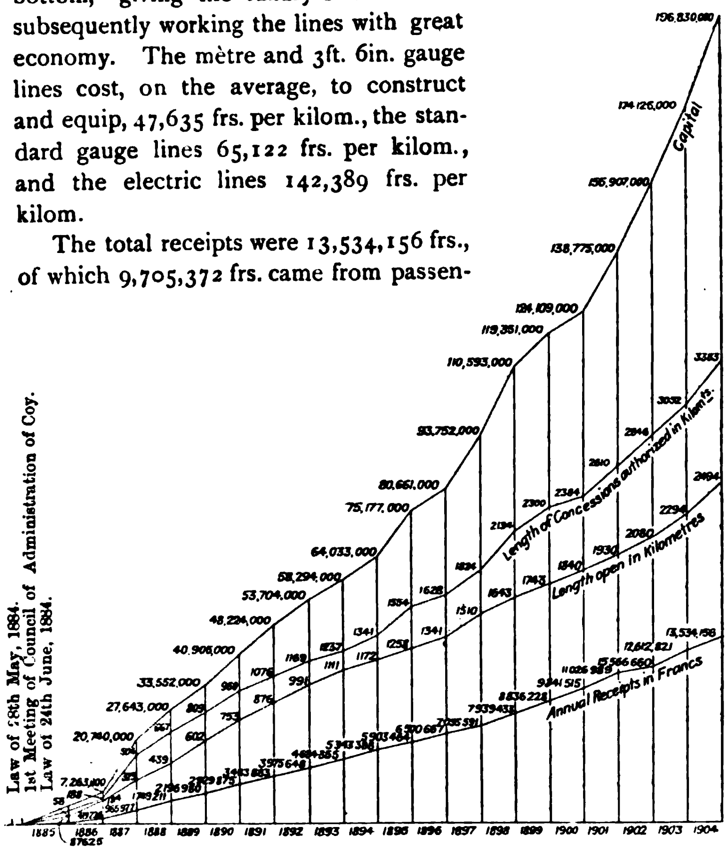
The capital of these railways is 196,830,000 frs., of which the State holds 39·8 %, the Provinces 28·4 %, the Communes 30·1 %, and others 1·7 %.

The rolling stock consists of 477 locomotives, 2 motor carriages, 1,185 composite 1st and 2nd carriages, 52 brake carriages, 281 baggage vans, 2,915 high-side wagons; 589 closed wagons; 374 low-side wagons and 47 miscellaneous wagons. For the electric lines there are 127 motor cars, 107 closed and 36 open trail-cars, and 6 goods wagons.

As regards the safety of these feeder railways the following particulars are interesting. In 1904 the kiloms. run were 15,145,888, and the total casualties were 37 killed and 46 injured, including 15 killed and 7 injured under the head of "Suicide, drunk or deaf"; 4 killed and 1 injured "asleep on the track"; and 9 killed and 13 injured while crossing in front of the trains. Only 1 servant was killed and 7 were injured, 3 passengers were killed and 7 injured by entering or leaving trains in motion, and 4 others injured by a collision. Altogether 1 person was killed per 2·44 million kiloms. run, and 1 injured per 3·04 million kiloms. run.

The dividends paid are: to the State, 3·09 %; to the Provinces, rates varying from 3·65 % to 1·877 %; to the Communes, 3·25 %, and to shareholders, 4·73 %; the average return on the whole capital invested being 3·21 %. This successful result has only been obtained by cutting down the capital cost to the "rock bottom," giving the luxury of electric traction a wide berth and subsequently working the lines with great economy. The mètre and 3ft. 6in. gauge lines cost, on the average, to construct and equip, 47,635 frs. per kilom., the standard gauge lines 65,122 frs. per kilom., and the electric lines 142,389 frs. per kilom.

The total receipts were 13,534,156 frs., of which 9,705,372 frs. came from passengers, 46,128 from parcels, 3,572,842 frs. from goods, and 209,813 frs. miscellaneous.



The passenger lines, including most of the electric lines, and which do not carry goods, are worked at 71·59% of the receipts; the lines which do carry goods are worked at 66·55%; the general average being 67·57%.

For the passenger lines the receipts and expenses per day-kilom. were 67·94 frs. and 48·64 frs., per train-kilom 0·68 fr. and 0·49 fr., and per route-kilom. per annum 24,865·3 frs. and 17,801·2 frs.

For the goods and passenger lines these particulars are:—Per day-kilom., 13·04 frs. and 8·67 frs.; per train-kilom., 0·97 frs. and 0·65 frs.; per route-kilom. per annum 4,771 frs. and 3,174·9 frs.

The director of this well-managed company is Mons. C. de Burlet, and we append a diagram which shows at a glance the progress of the undertaking since 1885 to the end of last year.

In conclusion we may add that it is now possible to travel

(not in through carriages) across Belgium in any direction entirely by these light railways, as they have been so largely linked up that but few gaps remain.

Books, Papers, and Pamphlets.

The Mechanical Handling of Material. By GEO. FREDK. ZIMMER Asso.M.Inst.C.E. London: Crosby, Lockwood and Son, 7, Stationers' Hall Court, E.C. 1905.

This is one of the most important of the technical treatises that have been issued for some time. It is the only work on the subject in English, and the author states that he has been unable to discover a "complete and connected treatise" on the subject in any language.

The title, though a very comprehensive one, accurately indicates the contents of the book, which is the result of carefully digested notes, data, tables, and general information collected during an experience in the designing and construction and erection of plant for the mechanical handling of material extending over a period of twenty years—in short, it conveys to the engineering profession the benefits of the knowledge and experience of an expert and specialist.

Illustrations are a feature of the work. Altogether there are 542 figures, but as many of these are folding drawings the mere number of them does not give at all an adequate idea of the prominence which has, very properly, been given to, on the whole, good illustrations of the plant and appliances described.

Chapters I. to XIV. are devoted to the Continuous Handling of Materials by means of elevators; conveyors (worm, push-plate or scraper, trough cable, band and metal band); picking belts; travelling and vibrating troughs; gravity or tilting bucket conveyors; pneumatic elevators and conveyors; and conveyors for special purposes, such as timber, hot coke, &c. There is also a chapter on the tightening gears for elevators and conveyors, and summary of driving power required, speed of travel, and wear and tear of elevating and conveying machinery.

The next section, Chapters XV. and XVI., deals with the Intermittent Handling of Material, and treats of endless chain and rope haulage; rope ways and aerial cable ways, including appliances for coaling at sea.

The third section, Chapters XVII. to XXIV., covers Unloading and Loading Appliances, such as skips and garb; the discharge of vessels and barges by means of elevators; self-emptying boats and barges; discharging railway trucks; coal tips; colliery tipplers; and automatic loading devices.

The last section, Chapters XXV. to XXX., includes miscellaneous subjects, viz., automatic weighing appliances; locomotive coaling plants; coal handling plant for gas-works, power houses, &c.; floor and silo warehouses for grain and seeds; coal stores and coal silos; and high-level or cantilever cranes.

While it is difficult to pick out from among so many chapters of almost uniform excellence any that might be described as the best, we have no difficulty in selecting as the poorest No. XX. Discharging of Railway Trucks. A comparison between British and American Railway Rates cannot be usefully stated in a few lines, and much better British-built examples of hopper wagons might easily have been obtained than any of the British (with the exception of the G.W.R. ballast wagon) and German ones illustrated. With this exception the book is a valuable addition to the technical literature of the country.

*

Books Received.

Earth and Rock Excavation. A practical treatise. BY CHARLES PRELINI. With tables and many diagrams and engravings. New York: D. Van Nostrand Company. London: Crosby, Lockwood and Son, 7, Stationers' Hall Court, Ludgate Hill. 1905. [357 pp. 9¼ins. by 6ins., price 16*s.* net.]

The Compound Engine. An introductory manual. BY W. J. TENNANT, A.M.I. MECH. E. London: Percival Marshall & Co., 26-29, Poppin's Court. Fleet Street, E.C. [202 pp. 7ins. x 4¾in., price 2*s.* 6*d.* net.]

Summer Holidays. BY PERCY LINDLEY. London: 30, Fleet Street.

This is the Great Eastern R.Co.'s new handbook. It is an excellent guide to East Anglia and is of a convenient size for the pocket. It contains a list of all the golf links on the G.E.R. and is full of good coloured illustrations.

The Miniature Railway at Blackpool and the building of the "Little Giant." Published by the Miniature Railway of Great Britain, Ltd., 22, Kingswell Street, Northampton.

This pamphlet describes the construction of an "Atlantic" type engine about one-quarter full size, and its testing upon the Duke of Westminster's private railway at Eaton Hall. It is fully illustrated. The Little Giant weighs 2,400lbs., and its tender 850lbs., and develops 8 h.p. It attained an average speed of 22½ miles per hour with a load of 2½ tons behind the tender.

Electric Locomotives; Metropolitan Railway.

THE first of ten 50-ton electrical locomotives has just been supplied to the Metropolitan R. by the British Westinghouse Company, the contractors for the electrification, and will shortly be put in service both in the Harrow and Inner Circle section of the line

They will be used for hauling the main line trains between Harrow and Baker Street, the steam locomotive that brings them up from Aylesbury, &c., being taken off at the former point and put on at the return journey. The trains used on this portion of the line are 120 tons in weight, and the new locomotives will propel them at a speed of 36 miles an hour on the level.

The same locomotives will be used on the Metropolitan half of the Inner Circle for goods traffic and for hauling the steam trains of other companies possessed of running powers over it. The electrical locomotive will pick up the train at Edgware Road, being replaced by a steam locomotive at the point where the train leaves the Circle.

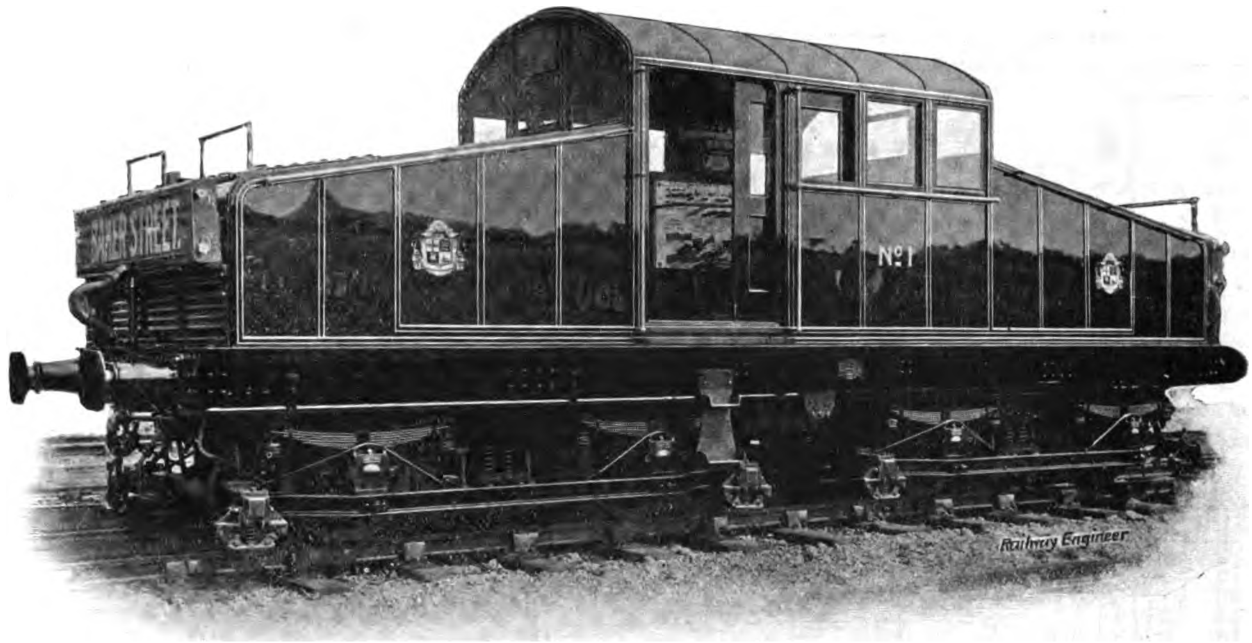
The new locomotives will be equipped with four motors of 300h.p. each; and a feature of interest is that, owing to the terminus facilities being somewhat restricted, it has been necessary to use motors of a smaller size than usual equipped with forced ventilation, so as to keep down the length of the locomotives to convenient limits for handling at the termini.

This course of substituting electrical locomotives for steam is the only one possible for running trains that have been designed for steam propulsion over electrified lines, and within a reasonable time the electrical locomotive will doubtless become a familiar object. In a subsequent issue we shall give further illustrations of these locomotives.

The bogies, framing, &c., were constructed under a sub-contract by the Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd., of Birmingham.

Electric Locomotive; Swedish State Railways.

THE illustration shows a single-phase electric locomotive, supplied by the British Westinghouse Electric and Manufacturing Company for the Swedish Government. One of the interesting features is the high trolley voltage for which the equipment is designed—18,000 volts.—though connections are supplied for operating at several voltages lower than this, the minimum being 3,000 volts. This high voltage necessitates the use of an oil cooled main auto-transformer, and an oil break circuit breaker, oil having insulating properties which have been amply demonstrated by service in high tension transmission. The intention is to experiment at various line pressures, with a view to ascertaining



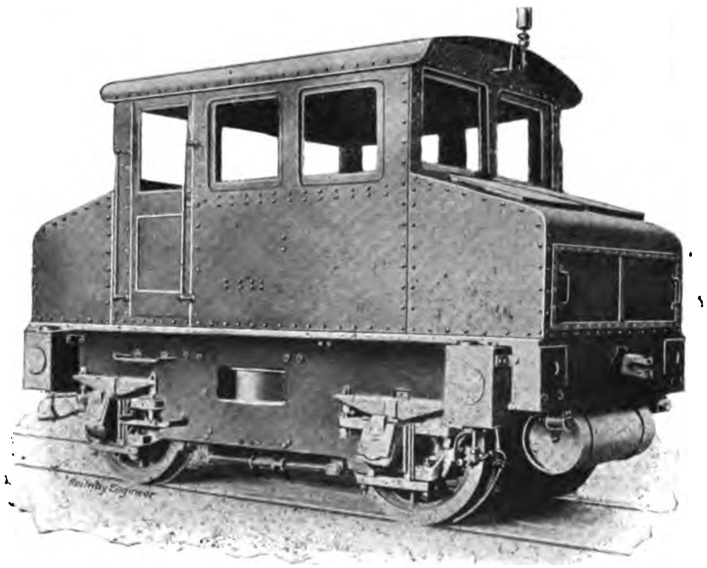
Electric Locomotive; Metropolitan Railway.

the highest working pressure suitable for the conditions prevailing upon the Swedish State Railways.

The control system is electro-pneumatic, and consists of an air compressor driven by a single-phase alternating current motor, an air motor on the induction regulator, air cylinders on the circuit breaker and reverser and the necessary magnet valves. The air brakes and air sanders are also to be supplied by the above compressor. There are two connectors at each end of the locomotive, so that two locomotives can be coupled together and operated by one motor switch. The master switch is in the middle of the cab, and is so situated that the operator has a clear view in all directions without leaving his seat.

The weight of the locomotive and equipment is 25 tons, all of which is on four 41ins. drive wheels. Two 150 h.p., 25 period, single-phase motors are geared, one to each axle, with a gear reduction of 18 to 70, and have shown an ability to handle a 70-ton train at 40 miles per hour, without exceeding the rise of temperature for which they were designed.

The equipment has been so installed on the locomotive as to permit ready access to all parts. Only the small operating devices have been placed in the cab, and the lay-out is such as to allow of the greatest convenience in operation with a maximum of safety to the operator.



Electric Locomotive; Swedish State Railways.

The illustration shows the locomotive as sent out from the makers' works, and it should be noted that buffers and collecting device, &c., are being fitted at the railway shops at Stockholm.

This locomotive has been built to the requirements of Mr. Robert Dahlander, director of the Electrical Department of the Swedish State Railways, who is about to carry out a most interesting series of experiments upon the application of electric power for main line railway service.

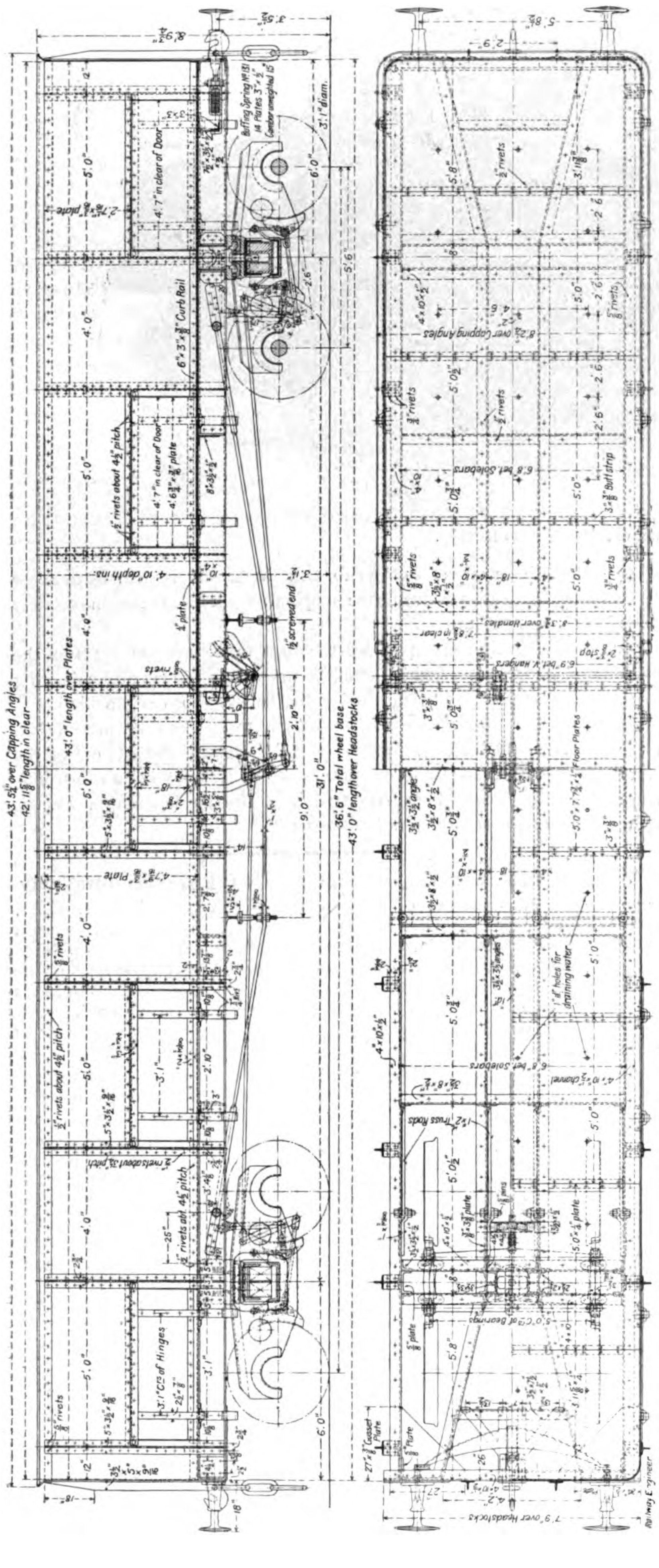
40 Ton Steel Bogie Wagons; Great Western Railway

By the courtesy of Mr. G. J. Churchward, M.Inst. C.E., chief superintendent of the locomotive carriage and wagon department of the Great Western R., we are able to publish the annexed drawings of the 40-ton bogie wagons which he has lately designed and built at Swindon for the company's "domestic" use., *i.e.*, carrying their locomotive coal.

The tare of these 40-ton wagons, which are constructed of steel throughout, is 18 tons 13 cwt., while that of a 10-ton coal wagon averages about 6 tons 1 cwt., so that on the haulage of dead weight there is a considerable economy. These wagons will also form a useful object lesson to private owners and serve to familiarise colliery owners, shunters and others with their use. As we have often shown the private owners have no direct financial interest in either reducing the tare of wagons or increasing their carrying capacity, and they are able to urge cogent reasons for not doing so, one of the chief of which is that it does not suit their customers to take their coal in large lots any more than it suits a railway company to take its locomotive coal in 40-ton wagons. For some few years some railway companies have been making every endeavour to spoil this line of argument by using wagons of large carrying capacity, and these large wagons that Mr. Churchward has built are another step in that direction. The annexed drawings are fully dimensioned and show clearly the construction of the wagon.

The dimensions of the body are 42ft. 11⅜ins. long, 7ft. 8⅝ins. wide, 4ft. 10ins. deep.

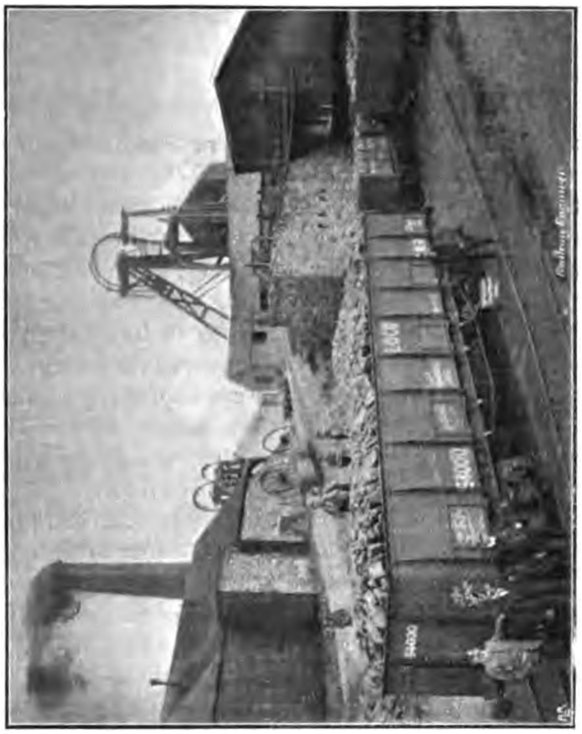
The length over the buffers 46ft., and between centres of bogies 31ft. Wheel base of bogies 5ft. 6in. Height from the rail to top of body unloaded is 8ft. 9¾ins. The wagons have five discharging doors on each side 4ft. 7ins. long by

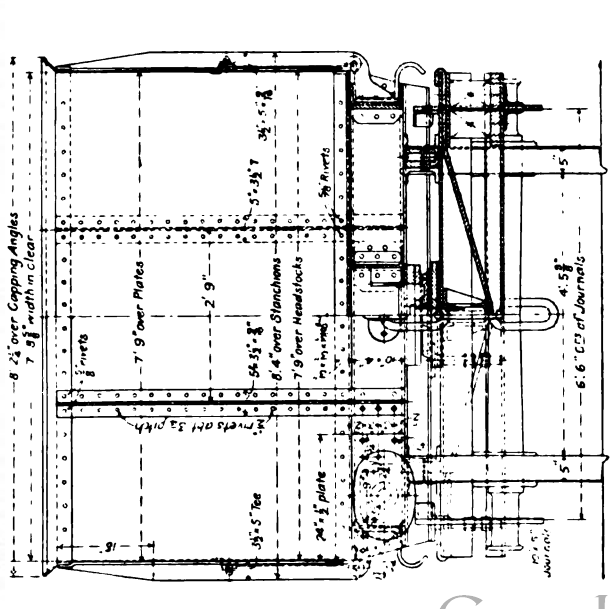


2ft. high, and are equipped with Churchward and Dean's "either-side" brake working blocks on all the wheels. The body plates are all butt jointed. The axle journals are 10ins. by 5ins. and the wheels 3ft. 1in. diam. on the tread.

The scantlings of the members are as under:—Body plates, $\frac{3}{16}$in. thick. Side and end stanchions, 5in. × 3½in. × $\frac{9}{16}$ T, the former being carried under the floor and riveted to the sole bars, which are 6ft. 8ins. apart. Floor plates, ¼in. thick. The sole bars, longitudinals, headstocks and bogie centre bearers are steel channels 10ins. × 4ins. × ½in.; intermediate cross-bearers angles, 8ins. × 3½ins. × ½in. The depth of the truss on the sole bars and longitudinals is 14ins., and the section of the truss rods 2ins. × 1in. The struts are screwed and provided with nuts for adjusting the trussing.

The bogies are similar to that illustrated in our issue for August, 1904.





40-Ton Steel Bogie Wagons; Great Western Railway.

Reinforced Concrete. III.

Calculations.

Mathematicians appear to have run riot when they have dealt with the calculations for reinforced concrete structures, and in this matter, if in nothing else, is it necessary for some common-sense individual to venture in and show to the "common or garden" description of engineering intellect how the abstruse methods of calculation rendered necessary, of course, by theory may be simplified so as to be used in actual work? It is necessary to take certain things for granted, but nothing more has to be assumed than in cases of ordinary girder construction.

The method given by Mr. Wason at the discussion on "Steel Concrete" before the American Society of Civil Engineers in 1901 appears to be one of the most easily understood of all these formulæ, and is as follows:—

$$f = \frac{Wl}{6\frac{2}{3}d}$$

Where f = total fibre stress in steel.
W = total load in lbs.
l = span in ins.
d = depth in ins. from the top to the centre of reinforcing bars.

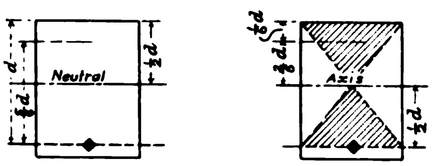


Fig. 1.

The concrete below the neutral axis is not considered in the computation. It is assumed that the steel takes the entire tensile stress and the concrete the entire compressive stress. The neutral axis is assumed to be halfway between the steel rod and the top of the concrete, fig. 1, the centre of pressure in the top half is, therefore, $\frac{2}{3}$ of the height from the neutral axis to the top and the distance between this point and the centre of the bar is $\frac{5}{6}$ of the depth.

The moment of the internal forces is, therefore, $\frac{5}{6}\,df$, and as the bending moment for uniformly distributed load is $\frac{Wl}{8}$

$$\text{we have } \frac{5}{6}\,df = \frac{Wl}{8}$$

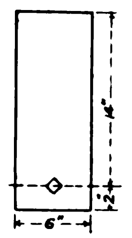
$$\text{or } f = \frac{Wl}{\frac{5}{6}\,8d} = \frac{6\ Wl}{40\,d} = \frac{Wl}{6\frac{2}{3}d}$$

if, therefore, it is assumed that

f = tension in steel = 16,000 lbs. per sq. in.
= compression in concrete of 1 : 3 : 6 composition
= 500 lbs. per sq. in.

we have $\frac{16{,}000}{500} = 32$ sq. ins. of concrete for each sq. in. of steel.

Applying this to the case of a reinforced concrete beam shortly to be referred to, fig. 2, 6ins. wide, 16ins. deep, 15ft. span,



$$f = \frac{Wl}{6\frac{2}{3}d}$$

Fig. 2.

ultimate load W = 15ft. × 2,000lbs. per ft. = 30,000lbs.

ultimate stress $f = 30{,}000 \times 15 \times 12 \div 6\frac{2}{3} \times 14 = 57{,}982$lbs.
and this divided by the prescribed stress for steel and a factor of safety of 4

$$57{,}982 \div 4 \times 16{,}000 = 0{\cdot}91 \text{ sq. ins. required.}$$

Now, applying it to a girder 30ins. deep and 6ins. wide of the same span and for the same loading, the depth to centre of reinforcement being 28ins.,

ultimate stress $f = 30{,}000 \times 15 \times 12 \div 6\frac{2}{3} \times 28 = 28.724$
and dividing again

$$28{,}724 \div 4 \times 16{,}000 = 0{\cdot}45 \text{ sq ins. required.}$$

Mr. A. L. Johnson, however, in the same discussion held the opinion that it was essentially incorrect to regard the neutral axis as being fixed halfway up the beam as in the calculation above, and stated that in a series of beams 12ins. deep the neutral axis was found to vary from a height of 4·74ins. to 10·2ins. above the bottom according to the disposition of the reinforcing rods.

Mr. Johnson gave a different way of working, and stated the case of a steel concrete girder beam of equal strength above and below the neutral axis, 15ft. span, to have an ultimate breaking load of 2,000lbs. per lineal foot.

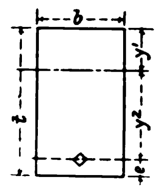
Neglecting the weight of the beam this is

$$M = \frac{12\ Wl}{8} = 675{,}000 \text{ inch-lbs.}$$

Two cases (I. and II.) of different moduli of elasticity were given, in case I.,

E_s = modulus of elasticity of steel	=	30,000,000lbs	per sq.in.
E_c = modulus of elasticity of concrete in compression	=	4,800,000	,,
F = elastic limit of steel	=	50,000	,,
f_c = compressive strength of concrete	=	1,500	,,
f_t = tensile strength of concrete	=	200	,,
b = width of section considered	=	6	ins.

a^2 = area of bars in sq. ins.
d = spacing of bars in ins.
$a^2 \div d$ = amount of metal per in. of width, in sq. ins.



$$t = y_1 + y_2 + e$$

Fig. 3.

and the formulæ work out as follows:—

$$y_2 = \frac{2\ F E_c}{3 f_c E_s} y_1 = \frac{2 \times 50{,}000 \times 4{,}800{,}000}{3 \times 1{,}500 \times 30{,}000{,}000} y_1 = 3{\cdot}55\ y_1$$

$$\text{and } M = \frac{Fa^2b}{d}\left(y_2 + \frac{2y_1}{3}\right) + \frac{8 f_t\, b\, y_2}{10}\left(\frac{y_2 + 2y_1}{3}\right)$$

$$= \frac{50{,}000 \times 6a^2}{d}\left(3{\cdot}55\ y_1 + \frac{2y_1}{3}\right) + \frac{1{,}600 \times 6 \times 3{\cdot}55\ y_1}{10}$$

$$\left(\frac{3{\cdot}55\ y_1}{2} + \frac{2y_1}{3}\right) = \frac{1{,}266{,}000\ a^2 y_1}{d} + 8{,}300\ y_1^2$$

but $\frac{a^2}{d}$ can be found as follows:—

$$\frac{a^2}{d} = \left\{ 75\ f_c\, y_1 - 64\ F y_1\left(\frac{f_t E_c}{f_c E_s}\right)\right\} \div 120F$$

$$= \left\{ 75 \times 1{,}500\ y_1 - 64 \times 50{,}000\ y_1\left(\frac{200 \times 4{,}800{,}000}{1{,}500 \times 30{,}000{,}000}\right)\right\} \div 120 \times 50{,}000$$

$$= 0{\cdot}00737\ y_1$$

substituting this value of $a^2 \div d$ in the moment equation we have

$$M = 17{,}625\ y_1^2 = 675{,}000$$
or $y_1 = 6{\cdot}20$ins.
$$y_2 = 3{\cdot}55\ y_1 = 22{\cdot}0\text{ins.}$$
$$t = 6{\cdot}20 + 22{\cdot}0 + 2 = 30{\cdot}2\text{ins.}$$
$$a^2\ b \div d = 0{\cdot}00737\ by_1 = 0{\cdot}00737 \times 6 \times 6{\cdot}20 = 0{\cdot}274 \text{ sq. in.}$$
or slightly more than one ½in. square bar.

In Case II. different values of E_c and f_c are taken as follows:
$$E_c = 2{,}400{,}000\text{lbs. per sq. in.}$$
$$f_c = 2{,}400\text{lbs. per sq. in.}$$
the other values being the same.

In this case, working through the same formulæ, we have:
$$y_1 = 6{\cdot}62$$
$$y_2 = 7{\cdot}35$$
$$c = 2$$
$$t = 15{\cdot}97 \text{ or say } 16\text{ins.}$$
and $\frac{a^2b}{d} = 1{\cdot}05$ sq. ins.

and this gives a beam 6ins. wide by 16ins. deep, with one 1in. square bar imbedded (fig. 2) as the equivalent to Case I., in which the beam is found to be 6ins. wide by 30ins. deep, with one ½in. square bar.

Comparing this with Mr. Wason's results it would appear that the latter are on the safe side, and the result is certainly much more easily ascertained than Mr. Johnson's figures are.

In a paper read before the Western Society of Engineers (America) Mr. T. L. Condron gives the following formula for the moment of resistance for "average rock concrete of the composition of one of cement, three of sand and six of broken stone, 1in. and under in size, dust screened out":—
$$M = (n\ P + 55)\ bd^2$$
Where M = moment of resistance, ultimate moment in inch pounds.
n = a constant to be taken as 450 for high elastic steel bars with positive bond to concrete, and 275 when plain bars of ordinary structural steel are used.
P = percentage of steel, not less than 0·5 nor more than 1·25.
b = breadth of beam.
d = depth „

This formula was, however, criticised by Mr. L. C. Sabin (*Engineering Record*, April 22nd, 1905), who pointed out "that "for every quality of steel, every quality of concrete has its "proper percentage of reinforcement if the stress developed in "each material is to bear a given ratio to its elastic limit or "ultimate strength. In other words, the percentage of reinforce-"ment is fixed by the relative working stresses allowed and by "the relative moduli of elasticity. To use a smaller area of steel "than this specific percentage is to lower the working stress in "concrete, while the use of a larger percentage, or excessive "reinforcement, results in lowering the working stress of the "steel below the assumed safe value."

Referring again to the beam of Case II. (fig. 2) above the value of M will be
$$\frac{Wl}{8} = \frac{30{,}000 \times 15 \times 12}{8} = 675{,}000 \text{ inch pounds.}$$
and taking the value of $n = 450$, the equation becomes
$$675{,}000 = (450\ P + 55)\ bd^2$$
$$675{,}000 = (450P + 55)\ 6 \times 16^2$$
$$(675{,}000 \div 6 \times 16^2) - 55 = 450\ P$$
$$P = 0{\cdot}853 \text{ percentage.}$$
and in case the value of $n = 275$
then $P = 1{\cdot}396$ percentage.

The percentage required by Wason's formula for the same beam is
$$6 \times 14 \times 100 \div 0{\cdot}91 = 100 \div 92 = 1{\cdot}09$$

Another formula is that said to be used by W. B. Wilkinson and Co. for concrete of the best quality, laid by special workmen, and containing $\frac{1}{60}$ of the sectional area in steel embedded in the lower half of the thickness.
$$W = \frac{12\ t^2}{s^2}$$
where W = safe load in cwts. per foot super.
t = the thickness in inches.
s = span in feet.

then for the last example of beam (fig. 2)
$$W = 12 \times 14^2 \div 15^2 = 10{\cdot}67\text{cwts.} = 1{,}195\text{lbs. per foot super.}$$
or $1{,}195 \times 15 \times \frac{1}{2} = 8{,}962$lbs. on the beam in question;
but the beam is required to carry an ultimate load of 30,000lbs., and in this case the factor of safety will be
$$30{,}000 \div 8{,}962 = 3{\cdot}34, \text{ which is too small.}$$
If a factor of safety of 4 be required, the formula would read
$$W = \frac{10{\cdot}25t^2}{s^2} \text{ in this case.}$$

Mr. A. J. Jenkins gives a formula of similar character to this:
$$W = 6\frac{t^2}{s^2}$$
but in this case the reinforcement is to be only $\frac{1}{200}$ the sectional area of the concrete slab.

Professor A. N. Talbot, in his paper read before the American Society for Testing Materials, gives the formula for finding the neutral axis, as follows:—
$$k = 0{\cdot}26 + 0{\cdot}18\ p$$
where k = proportionate depth of the neutral surface
p = number of percentage of the steel area.

Thus in the case of the beam previously referred to, where the percentage of reinforcement is 1·09, the formula will find:—
$$k = 0{\cdot}26 + 0{\cdot}18(1{\cdot}09) = 0{\cdot}26 + 0{\cdot}1962 = 0{\cdot}4562$$
and the following equation is given for the value of the resisting moment:—
$$M = (0{\cdot}9 - \tfrac{1}{15}p)Asd$$
where M = moment of resistance
p = number of percentage of reinforcement
A = area of the steel
s = stress per unit of area
d = distance from the top of the beam to centre of steel.

For 1 per cent. reinforcement this formula becomes $\frac{5}{6}$ Asd, and for 1½ per cent. of reinforcement 0·8 Asd

In the particular case before us, with the 1·09 percentage of reinforcement, we have—
$$M = \left(0{\cdot}9 - \tfrac{1}{15}(1{\cdot}09)\right)Asd = 0{\cdot}825\ Asd$$
and filling in the values of Asd.
$$M = 0{\cdot}825 \times 0{\cdot}91 \times 16{,}000\text{lbs.} \times 14\text{ins.} = 168{,}168 \text{ inch-lbs.}$$
but the ultimate bending moment is required to be 675,000 inch-lbs., which gives a factor of safety of
$$675{,}000 \div 168{,}168 = 4{\cdot}013$$
which agrees very well with the factor of safety adopted before in these calculations.

Mr. H. Alexis d'O. Saubrey, of the Ransome and Smith Co., gives the following formula for the approximate value of d, the depth of the reinforced concrete beam—
$$d = \frac{l}{30}\sqrt{t}$$

where l = length of beam in feet

t = load in lbs. per square ft. uniformly distributed.

Still neglecting the weight of the beam itself this works out, in the case already before us, to

$$d = \frac{l}{30}\sqrt{t} = \frac{15}{30}\sqrt{1{,}000}$$

t being 2,000lbs. ultimate load on the beam per ft. run, or 4,000 lbs. per ft. super., and divided by the factor of safety of 4.

$$\frac{4{,}000}{4} = 1{,}000$$

so that d becomes $\frac{1}{2}(31{\cdot}62) = 15{\cdot}81$ins.

The corresponding stress is given by the formula

$$s \text{ in tons} = \tfrac{3}{4}d$$

and $\frac{3}{4}(15{\cdot}81) = 11{\cdot}86$ tons $= 26{,}566$lbs.

and giving 16,000lbs. to each sq. in., the amount of steel required will be

$$26{,}566 \div 16{,}000 = 1{\cdot}67 \text{ sq. in.}$$

on each foot width of beam, or

$$1{\cdot}67 \div 2 = 0{\cdot}835 \text{ sq. in. for the 6inch width.}$$

Mr. Saubrey also gives the following formula to get at the depth of the beam in such a way as to eliminate the otherwise necessary assumption of the dead load, which is, of course, an essential feature in all the other formulas.

The formula is

$$d = \frac{l^2}{125} + \frac{l}{30}\sqrt{p + 10}$$

where p represents the live or superimposed load on the floor in lbs. per sq. ft., and l = span in feet.

In the case in question l = 15ft., and p = 1,000 lbs. We have therefore :—

$$\begin{aligned} d &= \frac{15^2}{125} + \frac{15}{30}\sqrt{1{,}000 + 10} \\ &= 225 \div 125 + \tfrac{1}{2}\sqrt{1{,}010} = 1{\cdot}8 + \tfrac{1}{2}(31{\cdot}78) \\ &= 1{\cdot}8 + 15{\cdot}89 = 17{\cdot}69\text{ins.} \end{aligned}$$

which may be compared with the depth previously obtained of 15·81ins.

The result of the second should, of course, give a greater depth, but in order to check this we may add the weight of the beam to the previous load of 1,000 lbs. per ft. run.

12 lbs. to the sq. ft., 1in. thick by 17·69ins. (the depth d just obtained) = 212·28 lbs.

And by Mr. Saubrey's first formula we have

$$d = 15 \div 30\sqrt{1{,}000 + 212} = 17{\cdot}40\text{ins.}$$

The same authority also gives another formula for ascertaining the stress in a floor of the type shown in fig. 4, a common form of construction.

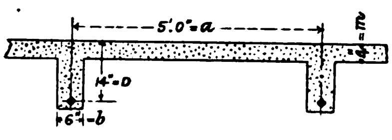


Fig. 4.

The formula is :—

$$s = \frac{(12m + p)l^2}{1{,}200D}a + \frac{bl^2}{1{,}200}$$

where s = stress in tons.

p = load in lbs. per sq. ft.

l = length in feet.

m = thickness of slab in inches.

D = depth of beam (including slab) in inches.

a = spacing of beams in inches.

In this case the following would result.

$$s = \frac{(48 + 1{,}000)\,225}{1{,}200 \times 14} \times 5 + \frac{6 \times 225}{1{,}200}$$

$$= 71{\cdot}28 \text{ tons.}$$

but of course the load is ten times the width of that in the case of the beam, so that to correspond this value of s should be divided by 10 which finds

$$71{\cdot}28 \div 10 = 7{\cdot}12 \text{ tons as the stress}$$

or 15,971lbs.

Area required at 16,000lbs. per sq. in.

$$15{,}971 \div 16{,}000 = 0{\cdot}99 \text{ sq. ins.}$$

A result which not only provides for the carrying of the dead load of the beam together with the moving load p per super. foot, but also for the support of the dead load of the slab floor.

Enough then has been said to show that for practical purposes very simple formulas will meet the case, but it must not be neglected that everything depends on the strength and modulus of elasticity of the metal and the concrete, and the material should not be used unless it is found satisfactory, and in accordance with the formula that is adopted.

Compound Locomotives at Home and Abroad.

By Chas. Lake.

The introduction of compound locomotives on the Great Northern R. and their impending introduction on the Great Central R., added to the extended use which is being made of such engines on the Midland and Great Western systems, will revive in this country, once again, practical interest in the subject of compound locomotives; an interest which has, of late years, shown signs of lapsing into something very like apathy.

The opinion that it is impossible—under the conditions which apply to locomotive operation—to obtain, in anything like full measure, the beneficial results arising from the employment of the compound principle in other branches of steam engineering, appears to be somewhat widely shared among engineers here, and this view is undoubtedly correct so far as it goes, for it is certain that no one has, up to the present, succeeded in obtaining results with compound locomotives equal to those derived from marine and stationary engines as regards economy and efficiency combined. This is, of course, due to the fact that in the other branches mentioned the conditions of working are practically uniform, the load and speed being virtually constant, whereas in the case of the locomotive these factors are frequently changing and the conditions generally are necessarily of a highly variable character.

The much debated question as to whether the compound locomotive can be made to successfully compete against the "simple" engine, after taking into consideration such matters as first cost, maintenance and so forth, appears to have been settled long ago abroad in favour of the former method.

Upon the Continent the multiple expansion locomotive flourishes to such a degree in modern practice as almost to involve the extinction of the other type, just as in the past the single-expansion marine and stationary engine disappeared before the advancing popularity and consequent wholesale adoption of the compound condensing engine.

Although it is not as yet possible to foretell whether we are likely to witness a reversal of policy in connection with British locomotive practice similar to that which has already

taken place abroad, present indications are certainly favourable to the assumption that such an eventuality may ultimately come about, although it will probably be many years before the condition of affairs existing abroad will have supplanted the methods at present observed in this country.

To the introduction last year on to the Great Western R. of the first De Glehn-du Bosquet compound engine to work in this country as much as anything else must be ascribed the present indications of a disposition to submit compound locomotives more exhaustively to the test than before.

As a set off to these anticipations there is to be considered recent locomotive practice on the L. and North Western R. This has been cited, not infrequently of late, as evidence, if that were necessary, of the unpopularity of compound locomotives among British engineers. The circumstances of the case are however of a somewhat special character. As everyone is aware, changes in the ranks of those in authority are more often than not productive of other changes also, and it is known that Mr. Webb's ideas on the subject of locomotive design, and especially in respect of compounding, were not wholly shared by certain of his officers occupying responsible positions at Crewe. Although this did not deter the late chief mechanical engineer—a man of exceptionally strong personality and ability—from continuing the development of his system of compounding (in connection with which he achieved a far longer measure of success than some of his critics, professional and otherwise, are prepared to admit), it bears a more or less direct relationship towards the altered policy now in vogue on the L. and North-Western R. after some 22 years of development on opposite lines. In any case, to sum up the whole question of locomotive compounding and to identify the many issues contained therein with the views and practice of any one individual designer—no matter what the degree of his success or non-success may have been—is obviously to treat the matter in the most superficial manner possible, better calculated to retard than to expedite arrival at the truth as to the merits and demerits of the principle under discussion.

A great deal of controversy has taken place from time to time on the design of compound locomotives, involving such points as the number and arrangement of the cylinders, the relative angles of cranks, cylinder ratios, and so forth, each possessing vital importance and requiring consideration as a governing factor in the scheme of construction. By degrees a tendency to consolidate opinion with regard to the adoption of proportions best calculated to ensure the desired results being obtained is manifesting itself, so that it may reasonably be hoped that in time to come the principle of standardising, already so usefully employed in connection with the question of the features and dimensions necessary in locomotives for the accomplishment of certain specified duties, will be extended to the more abstract problems associated with the design and arrangement of compound cylinders.

The two-cylinder compound locomotive, although still largely employed abroad, more especially in connection with goods traffic, does not enjoy the amount of popularity that it formerly did, although it would be by no means difficult to point to several recent examples of construction both in America and upon the Continent in which this arrangement is retained. The four-cylinder engine, especially of the balanced type, is coming increasingly into favour abroad, but opinion seems to be divided in this country as to whether the three or four-cylinder arrangement possesses the greater merit. It is to be anticipated, however, that considerable light will before long be thrown upon this latter point as a result of the employment of both types, built in accordance with modern standards, in different styles, and from the designs of independent engineers such as will transpire when the new engines at present being built have been added to those already in regular service. The working results obtained with the three-cylinder Smith system compounds of the 4—4—0 type on the Midland and Mr. J. G. Robinson's forthcoming "Atlantic," with the same cylinder arrangement and mode of operation on the Great Central, should provide useful material for comparison with those met with in connection with the De Glehn compounds on the Great Western, and Mr. Ivatt's new four-cylinder compound locomotive on the Great Northern, whilst the performances of the De Glehn engine at present building by the Vulcan Foundry Company at Newton-le-Willows for the last-named railway will furnish additional data at a later stage.

The majority of engineers, when designing compound locomotives, adapt them for variable methods of working at the will of the driver, by providing devices by means of which additional power becomes available at starting or when working on up grades. It seems to have become recognised as an axiom that however much the design may differ from those of others in certain respects the presence of a "change valve" or other appliance having the same object is absolutely essential. The Webb compounds were not provided with an appliance of this description either in the three or four-cylinder types, and whatever other qualities they possessed it is an indisputable fact that they were not conspicuous as reliable starters.

Every compound locomotive to be successful must either be provided with starting mechanism in one or other of its many forms or have a large h.p. cylinder area, thus placing it on an equal basis with a simple engine under all conditions of service. To ignore this principle is to invite trouble at more or less frequent intervals not only under maximum, but also under normal conditions. A reduced h.p. cylinder capacity in conjunction with a starting device for utilising boiler steam at will in the l.p. cylinders seems to be preferred by most designers to the alternative plan of employing large h.p. cylinders and cutting off at an early stage in the piston stroke, but the latter system has its advantages and has given very good results so far as it has been tried.

The method of disposing the cylinders is largely a matter of convenience, but the two arrangements most commonly resorted to are those in which the cylinders, either three or four in number, are placed either in line below the smoke-box to drive the same axle, or are arranged in pairs to drive separate pairs of wheels. In a few cases a combination of the two arrangements is employed, the cylinders being retained in transverse alignment at the bogie centre, with the connecting rods varying in length to suit the differences in position of the axles to be driven. This plan allows of short steam passages between the cylinders, and at the same time the driving strains are distributed over two axles instead of being concentrated in one.

The Vauclain arrangement of superposed cylinders by means of which only two connecting rods are required for the four cylinders has not been largely adopted outside America and Canada, neither can the tandem principle, with its various modifications, be described as popular, or as likely to become so according to present indications.

The cylinder arrangement adopted by Mr. H. A. Ivatt in his recently completed compound locomotive for the Great Northern R. is that referred to above as combining certain advantages of other types in the one engine. As will be seen from the illustration, fig. 1, the locomotive is of the Atlantic (4—4—2) type, conforming in general outline to the No. 251 class "simple" engines of the same type on this railway. The four cylinders are arranged in line below the smoke-box, the two high-pressure ones being placed outside the frames to drive the second pair of coupled wheels, whilst the two low-pressure ones are between the frames and drive the cranked axle of the leading coupled wheels. The slide valves are of the open backed balanced type, working above the cylinders for the h.p., and in the case of the l.p. they are balanced by strips working against a rubbing plate placed between them. The low-pressure steam chest is arranged between and not above the cylinders as in the case of the high-pressure.

The high-pressure cylinders are 13 ins. diam. by 20 ins., and the low-pressure cylinders 16 ins. diam. by 26 ins. The coupled whels are 6 ft. 8 ins. diam. on tread, with 3 in. tyres. Other dimensions are as follows :—

Wheel base coupled, 6 ft. 10 ins.
,, ,, total, 26 ft. 4 ins.
Boiler, diam. outside, 5 ft. 6 ins.
,, length between tube plates, 16 ft. 0 ins.
,, heating surface, tubes, 2,359 sq. ft.
,, ,, ,, firebox, 141 sq. ft.
,, ,, ,, total, 2,500 sq. ft.
,, grate area, 31 sq. ft.
,, working steam pressure 200 lbs.

The engine weighs, in working order, 69 tons, distributed as follows :—

On bogie wheels, 18 tons 10 cwt.
On l.p. drivers, 18 tons 5 cwt.

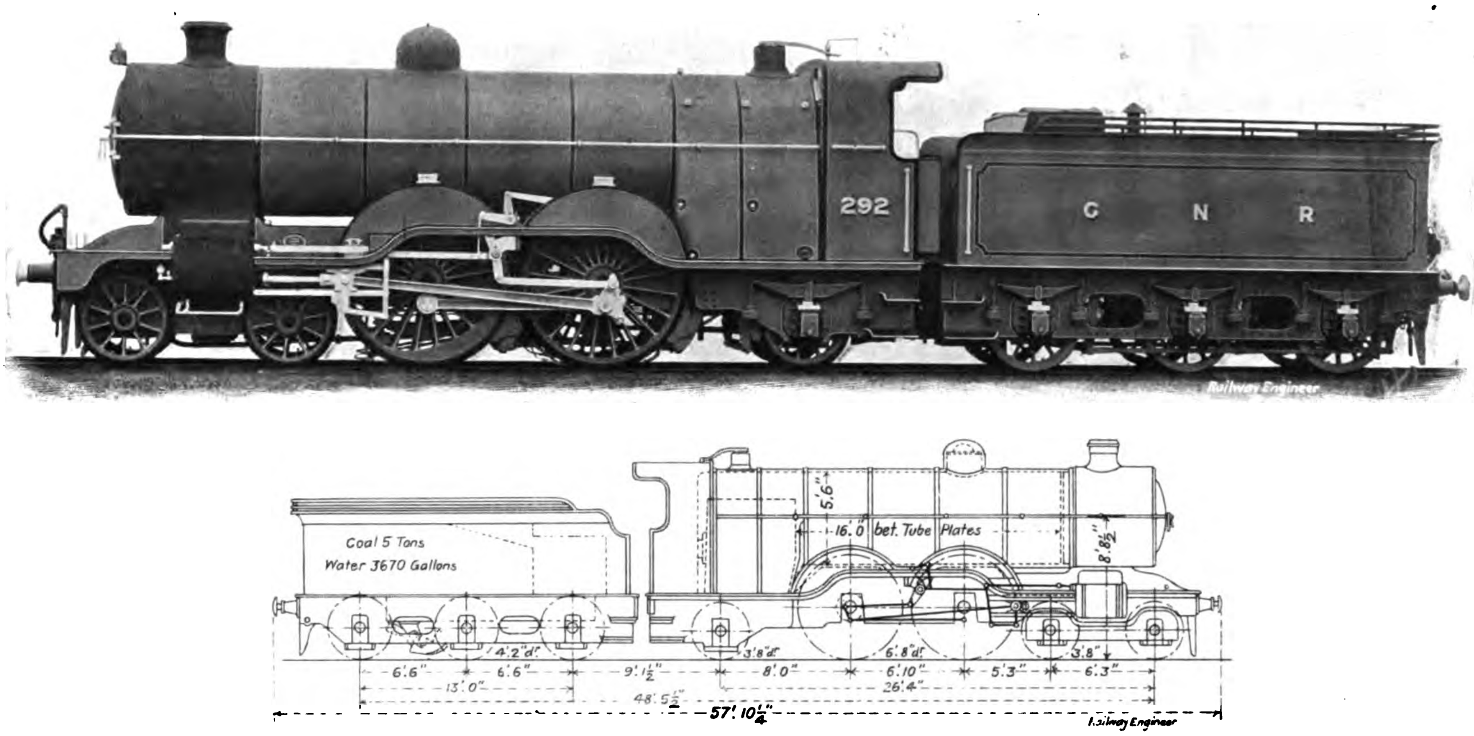


Fig. 1.—Atlantic (4—4—2) Type Compound Express Locomotive; Great Northern Railway.

Walschaerts' motion is employed for the outside and ordinary Stephenson gear for the inside cylinders, and two reversing levers with sectors placed close together on the footplate are provided. A vacuum lock placed on the middle of each reversing shaft enables each shaft to be locked in position from the footplate, thus obviating loss of motion between the shaft and footplate lever. This arrangement has already been applied by Mr. Ivatt to several other locomotives on the Great Northern R.

The engine illustrated can be operated either as a simple or as a compound at the will of the driver, a change valve being provided to allow of the admission of boiler steam direct to the l.p. cylinders when extra power is required. A small auxiliary steam cylinder, in connection with a water dash-pot, is used for working the change valve, and the arrangement is such that the change mechanism is locked in position either for simple or compound working.

On h.p. ,, 18 tons 5 cwt.
On carrying wheels, 14 tons 0 cwt.

A standard six-wheeled tender is provided having capacities of 5 tons of coal and 3,670 gallons of water, and weighing, loaded, 40 tons 18 cwts., the total for engine and tender in full running order being therefore 109 tons 18 cwt.

The compound locomotive at present building at the Gorton Works of the Great Central R., is substantially of Mr. Robinson's standard design of 4—4—2 type engine, several of which are in service. The only difference will be that a third cylinder, adapted for high-pressure working, will be located between the frames, whilst those outside utilise low-pressure steam. All the Great Central express engines of the 4—4—2 type are so built that they are readily capable of being converted to three or four-cylinder compounds by removing the steel casting between the frames below the smoke-box to make room for the other cylinder or cylinders. The

substitution of a crank axle for the plain one fitted would be the only other alteration necessary to convert the existing "'Atlantics" to compounds if such a course were decided upon.

Fig. 2 illustrates one of the most recent developments of locomotive compounding in France. In contradistinction to usual practice on French railways the De Glehn cylinder arrangement and methods of working are not employed in this case. The engines of the class illustrated were designed by Mons. C. Baudry, locomotive engineer of the Paris, Lyons and Mediterranean R., and they have four compound cylinders operated on the Henri system which, although in many respects similar to that of Mons. de Glehn, is considered by some to be an advance upon the latter system in certain respects. The cylinders are placed virtually in line, with the h.p. ones outside the frames driving the intermediate pair of wheels, and the l.p. ones inside, and slightly in advance of the outside cylinders, driving the crank-axle of the leading pair of coupled wheels. The h.p. connecting rods are necessarily of greater length than those inside, being 9 ft. 10 ins. long as compared with the 5 ft. 9 ins. of the l.p. rods.

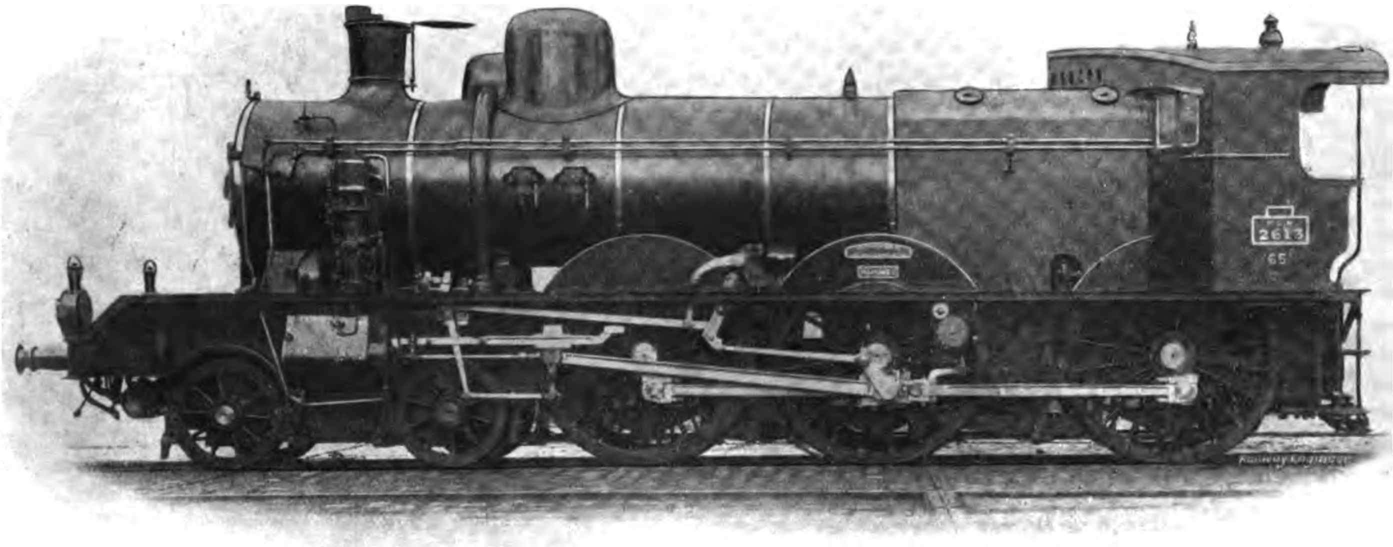


Fig. 2.—Four-Cylinder Compound Express Locomotive; Paris, Lyons and Mediterranean Railway.

Walschaerts' valve gear is employed for each of the four valves, and provision is made for independent regulation of cut off. This can be varied in the h.p. cylinders from 20 to 88 per cent. of the piston stroke, but the l.p. cut-off remains constant at 63 per cent. An arrangement for admitting boiler steam to the second cylinders at a reduced pressure is provided.

The boiler is of large size, with a Belpaire firebox. It carries a working pressure of 228lbs. per sq. in. The total heating surface is 2,388·5 sq. ft., and the grate area 32·4 sq. ft. The h.p. cylinders are 13½ ins. diam. and the l.p. 21½ ins. diam., both having a stroke of 25 ins. The coupled wheels are 6 ft. 6 ins. diam. on the tread. Twenty of these locomotives have recently been delivered to the P.L.M. Railway Co. from the works of the Franco-Belge Co.

Fig. 3 illustrates the latest type of Gölsdorf compound locomotive introduced upon the Austrian State Railways. The engine is of the 2—6—2 type, a pattern unusual outside America, but possessing many advantages where traffic has to be worked expeditiously over sections of railways abounding in curves and gradients. There are four cylinders, arranged in transverse alignment between the front truck wheels and the leading coupled wheels, with the h.p. cylinders outside and the l.p. cylinders between the frames, all driving the same axle, viz., that of the intermediate pair of coupled wheels.

The steam chests are placed above the cylinders, and Walschaerts' motion is used for working the valves, which are of the flat, balanced type. The pistons and valves have extension rods, working through the front covers.

The boiler is of large proportions and has a coned ring next the fire-box. The latter is of the wide type, resting upon the tops of the frame plates, which are dropped throughout its length. The dome, upon which are mounted two safety valves of the Coale type, is located upon the coned ring of the boiler. The engine can be operated either as a simple or as a compound, and it, with others of the same class, has the following leading dimensions :—

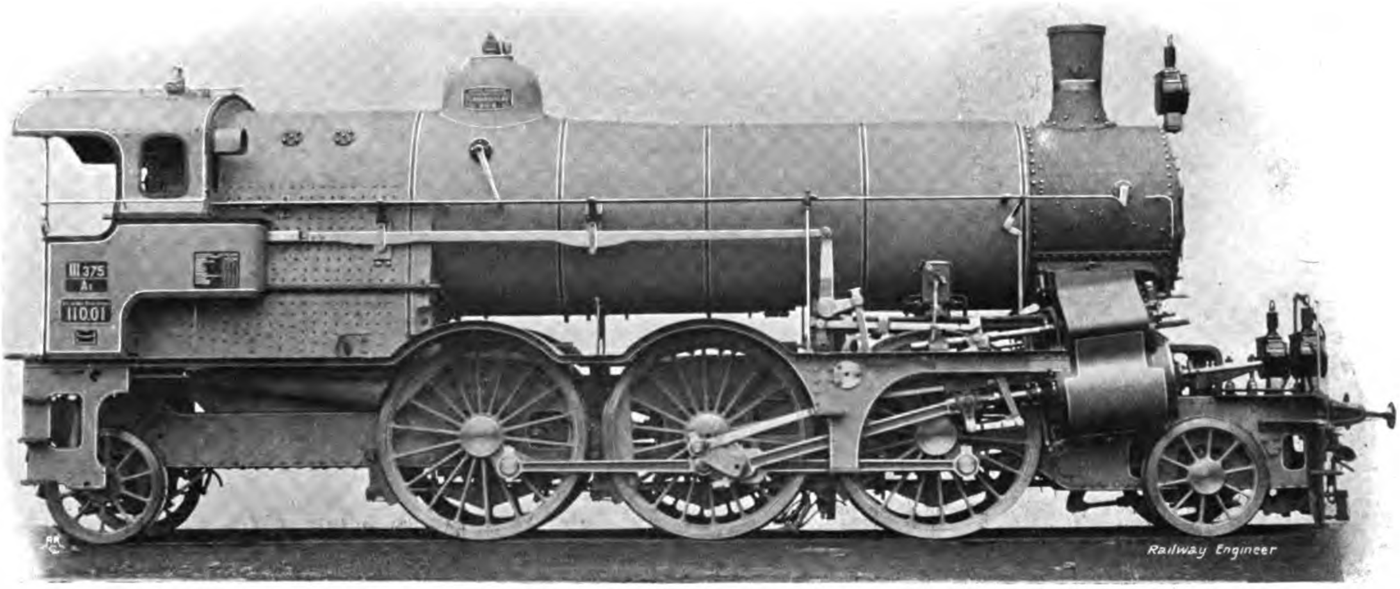
Cylinder h.p. 14½ ins. by 28¼ ins.
,, l.p. 24¾ ins. ,, ,,
Wheels, leading and trailing, diam. 3 ft. 4¾ ins.
,, coupled, diam. 6 ft. 0 ins.
Wheelbase coupled, 12 ft. 9½ ins.
,, total, 31 ft. 1¾ ins.

The distance between rail level and centre line of the boiler is 9ft. 5 ins.

282 tubes 2 ins. diam., and 17 ft. 0¾ in. between the tube plates.

Heating surface tubes 2628·06 sq. ft.
,, ,, fire-box 147·47 sq. ft.
,, ,, total 2775·53 sq. ft.

Among the latest locomotives put into service for working express passenger trains on the New York Central and Hudson River RR. are some four-cylinder compounds of the Atlantic type. In this design, which is illustrated by fig. 4,



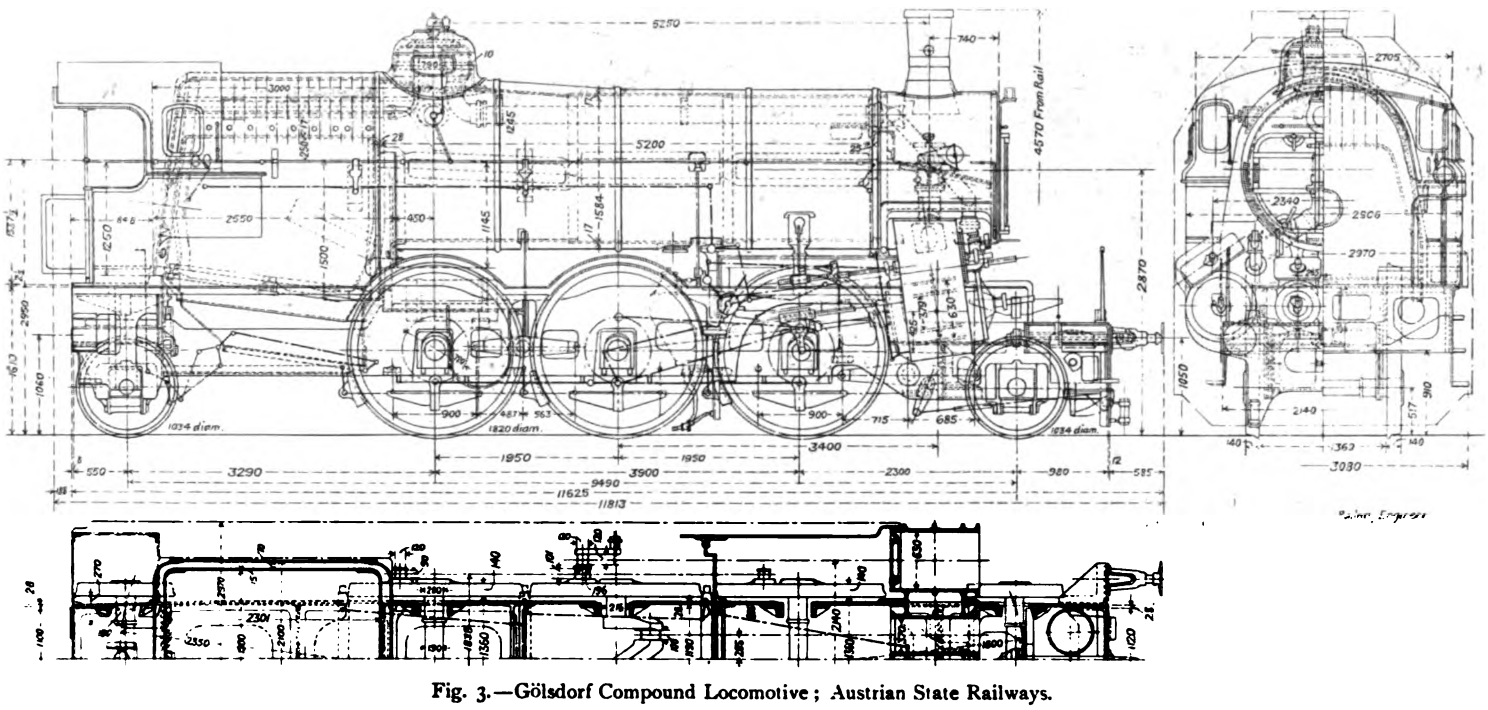


Fig. 3.—Gölsdorf Compound Locomotive; Austrian State Railways.

the cylinders are arranged with the low-pressure outside the frames, between the bogie wheels, and driving the rear pair of coupled wheels. The high-pressure cylinders are between the frames in advance of the smoke-box. These drive the crank axle of the first pair of coupled wheels, and owing to their being carried out beyond the usual position a greater length of connecting rod is possible, whilst retaining a normal length of wheel-base.

Only two sets of valve gear are employed for actuating the four valves, the latter being of the piston type arranged tandem wise upon the same stem on each side of the engine. The gear itself is of the link motion type, driven off the l.p. driving axle. The locomotives were built by the American Locomotive Co. at their Schenectady Works, from the designs of Mr. Francis J. Cole, mechanical engineer. The first of the type was exhibited at the St. Louis Exposition, and in connection with this exhibit the builders issued a statement embodying their views upon the subject of compound locomotives, with special reference to those of the type under notice. This statement, which forms interesting reading, is as follows :—

Two-cylinder cross compounds have been largely used in passenger service, and four-cylinder tandem compounds in freight service. In both the reciprocating parts have, with the gradual increase in the size of locomotives, become very heavy, and driving wheel counterbalances have been increased to correspond. This increase of counterbalance, while improving the horizontal balance, has simply aggravated the troubles which result from imperfect vertical balancing, and they have been still more seriously affected by the great increase in speed required, especially in passenger locomotives. The use of four cylinders, arranged in pairs, so related and connected that the pistons of each pair are always moving in opposite directions, and with recipro-

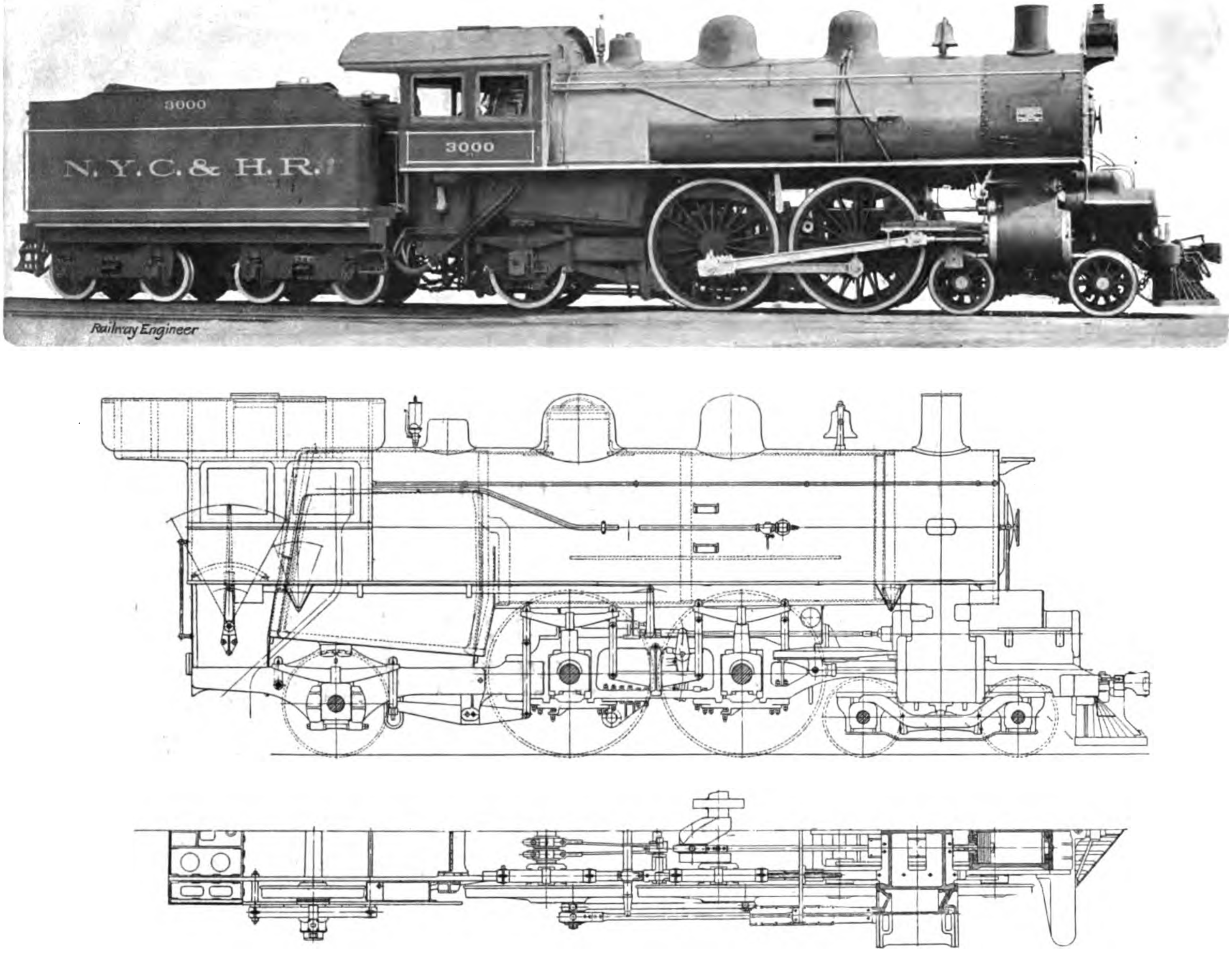


Fig. 4.—Four Cylinder Balanced Compound Locomotive; New York Central and Hudson River Railroad.

cating parts so proportioned that they are approximately of the same weight, makes it possible to either eliminate all counterbalance from the driving wheels or reduce it to an inconsiderable minimum. This idea has been in several designs, notably the De Glehn engine, which has been largely and successfully used in France. In that engine the separate location of the two sets of cylinders makes it necessary to provide two complete sets of valve motion, one being outside the frames and the other inside. This requires the use of motions of two different types which are not interchangeable. In the engine exhibited (Fig. 4) the four cylinders are in a group and are so related that it has not been necessary to duplicate the valve motion or to depart in any way from the best previously accepted practice.

The use of four cylinders, two high and two low-pressure, gives an opportunity for compounding under the most favourble conditions, and with each high-pressure piston working 180 degrees from its low-pressure piston and the other pair working 90 degrees from the first pair the successive impluses from the four cylinders produce a remarkably uniform turning moment. This results in a much more rapid rate of acceleration when starting than has been possible with two cylinder engines or with many previous types of four cylinder engines.

In order to avoid the concentration of work on a single driving axle it has been considered best to connect one pair of cylinders to the forward axle and the other pair to the rear one. This is accomplished by placing the h.p. cylinders between the frames and locating them slightly in advance of the usual position, so as to secure the necessary length of space for the connections, crossheads, guides, connecting-rods, &c.

With this relative arrangement of each pair of one h.p. and one l.p. cylinders it has been possible to apply both a high pressure and a low pressure piston valve to the same stem, and to utilise the intermediate portion of the valve chamber as a receiver between the two cylinders.

The advantages of this type of engine may be summed up as follows:—

(1) The elimination of counterbalance weights from the driving wheels, the engine being nevertheless in perfect balance both horizontally and vertically. This results in the complete absence of slip at high speed.

(2) The more perfect compounding which results from this arrangement of cylinders, whereby it becomes possible to secure more favourable cylinder volume ratios than with the two cylinder compound.

(3) The consequent approximately uniform turning movement throughout each revolution.

(4). The power of quick acceleration resulting partly from the uniform turning moment and partly from admitting to the l.p. cylinders at the time of starting and through a special starting valve live steam at reduced pressure.

(5). The reduction of stresses in the driving axles, crank pins and other parts of the machinery due to the system of distributing power from the cylinders, approximately one-half being transmitted to the forward driving axle and one-half to the rear axle.

(6). Increased hauling capacity and endurance at high speed, due principally to the perfection of the compounding and the consequent economical use of steam, but partly also on account of the perfect balance of the reciprocating and revolving parts.

The New York Central locomotives of the type illustrated have the following dimensions:—

Cylinders, h.p., 15½ ins. diam. by 26 ins. stroke, l.p. 26 ins. by 26 ins.

Coupled wheels, diam. 6 ft. 7 ins., coupled wheel-base 7 ft. 0 in. Total wheel-base 27 ft. 9 ins.

Total heating surface, 3446·1 sq. ft.

Grate area, 50·23 sq. ft.

Working pressure, 220 lbs. per sq. in.

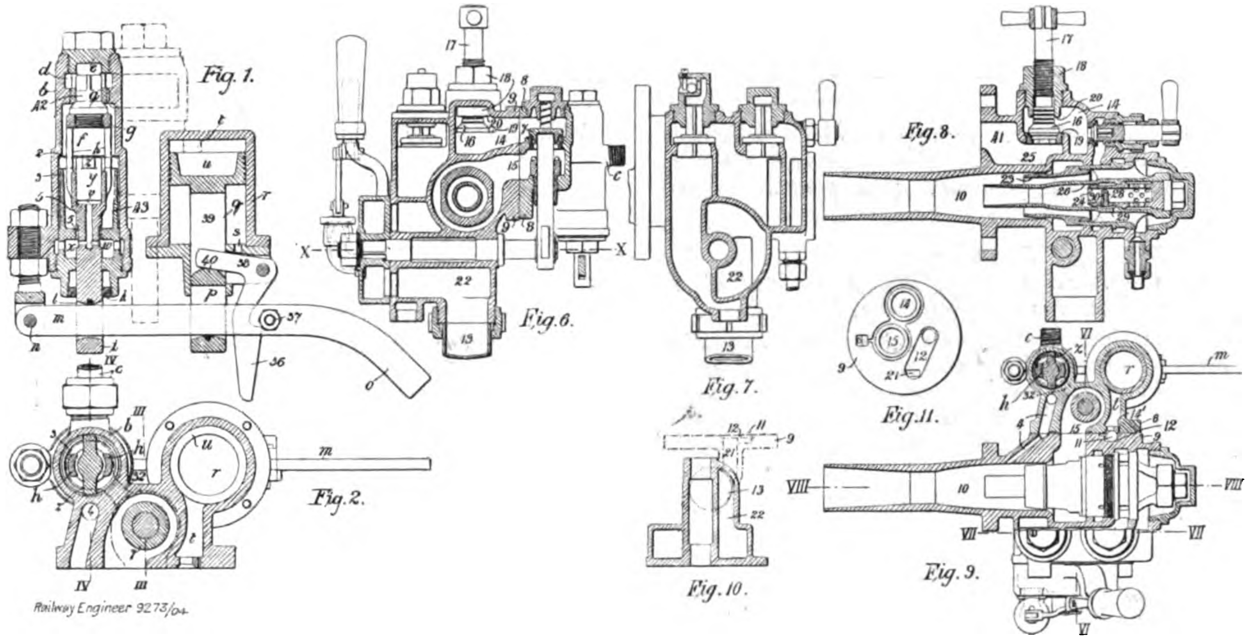
Adhesion weight, 49 tons 2 cwts. Total weight (engine) loaded, 89 tons 5 cwts.

Recent Patents relating to Railways.

THESE abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d*. each.

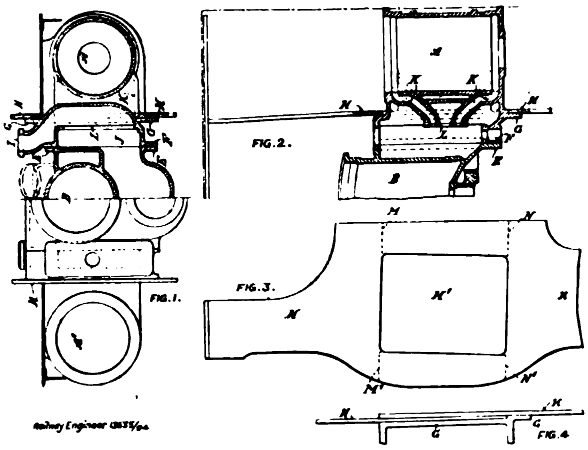
Brakes. *9.273. 22nd April, 1904. J. Gresham, H. E. Gresham, and G. Kiernan, Craven Iron Works, Ordsall Lane, Salford.*

Relates to apparatus for connecting the vacuum brake system with the steam brakes of a locomotive. The steam valve *a* is screwed into a ring *g*, supported by webs *h* from a spindle *i*, which passes through a stuffing box *k*. A lever *m* passes through a slot in the valve spindle *i*, and also through a slot in a piston rod *q*, the piston *u* of which works in a cylinder *r*. One end of the cylinder *r* communicates with the atmosphere through an aperture *s*, whilst the other end is in communication with the train pipe of the vacuum brake. In order to relieve the valve spindle *i* from an axial pressure due to steam in the chamber *f* when the valve *a* is open, the valve spindle *i* is formed with an enlarged hollow portion *v* communicating by openings *w* with a chamber *x*, which opens into an exhaust passage 4. A plunger *y*, fitting in the hollow portion *v*, is supported by the valve casing *b*, but is not held rigidly, as regards lateral movement, in order that it may accommodate itself to suit the valve spindle, and thus obviate the necessity of perfect alignment of all the parts. When the valve *a* is closed the chamber *x* is in communication with the chamber *f*, by means of the valve 5, which forms the exhaust valve of the steam brakes. When the brakes are off, the piston *u* is forced upwards in its cylinder *r* by atmospheric pressure, and by pulling up the lever *m* closes the valve *a*. On air being admitted to the train pipe the lever *m* is freed and allows the valve *a* to open under pressure of steam, which passes by a chamber *f* and pipe *c* to the steam brakes. A cylindrical portion 42 above the valve *a* practically cuts off the steam for a certain movement of the spindle after the valve *a* has moved from its seat, whilst a similar part 43 fills the hole of the exhaust valve 5, so that valves *a* and 5 can be closed at the same time and either can be opened to increase or decrease the amount of pressure applied to the steam brake cylinder. The pressure in the chamber *f* depends on the pressure exerted on the lever *m* by the piston *u*, and thus on the pressure in the vacuum train pipe. When it is desired to prevent the steam brakes operating on the admission of air to the train pipe, a latch 36 may be pulled to engage a pin 37 on the lever *m*, to prevent the latter moving when the piston descends. The latch is, however, adapted to be automatically disengaged to release the lever *m* when the brakes are taken off by the piston rod 39, which engages an arm 38 on the latch. The controlling apparatus is shown applied directly to the ejector of the vacuum brake. To facilitate this the steam valve 7, which is operated as described in a prior Patent No. 20,304[03], is contained in the casting of the control apparatus. A stop valve 16 controls the admission of steam to a chamber 14, from which it can be allowed to pass to the injector. Modified forms of the invention are described in the specification. (*Accepted 20th April, 1905.*)



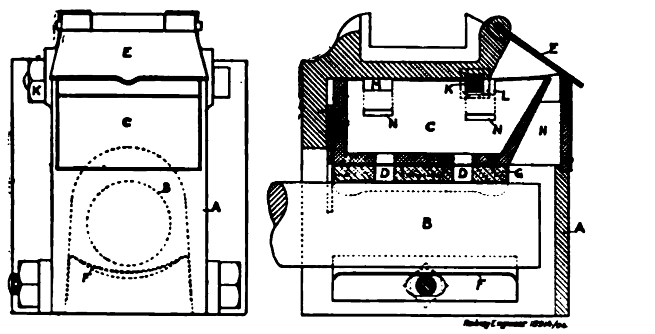
Locomotives. *13.635. 16th June, 1904. W. M. Smith, 16, Otterburn Terrace, Jesmond, Newcastle-on-Tyne.*

The cylinders of three cylinder compound locomotives are cast together in one casting, or are fixed firmly and directly together by suitable flanges, and the main engine frames are formed with openings through which the outside cylinders are passed, the latter being afterwards secured to the frame by means of flanges. This construction enables the three cylinders A, B and A^1, after they have been fitted and bolted together and without separating them to be got into position, the frame H being passed over the outside cylinders; it also enables the depth of the frame plates to be reduced, and the capacity of the steam chest J the steam ports K and the exhaust passages L to be increased so as to give a free admission of steam to the cylinders and a free passage for the exhaust steam from the cylinders, as, since these parts have not to pass through the openings H^1, they are not restricted by the size of the openings. (*Accepted 27th April, 1905.*)



Axle-Boxes (Wagon). *13,914. 20th June, 1904. J. J. Eley, The Grange, Outwood, Wakefield, York and T. Nawthrop, Newstead Terrace, Outwood, near Wakefield.*

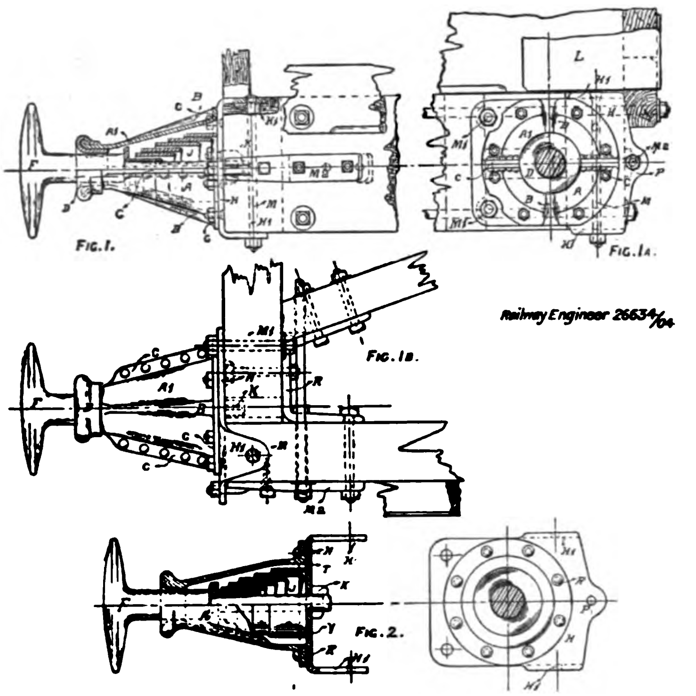
The sliding grease chamber or drawer C is provided with an internal overflow passage H, arranged to conduct any overflow of oil direct to the bearing, instead of allowing it to drip



over the front of the axle-box. It may also have side overflow passages M, N. A bolt K is passed through the axle-box to secure the drawer in position. (*Accepted 20th April, 1905.*)

Buffers. *26,634. 7th December, 1904. W. Gatwood, 9, Cavendish Road, Chorlton-cum-Hardy, Manchester, and G. H. Williams, The Hermitage, Rhosddu, Wrexham, Denbigh.*

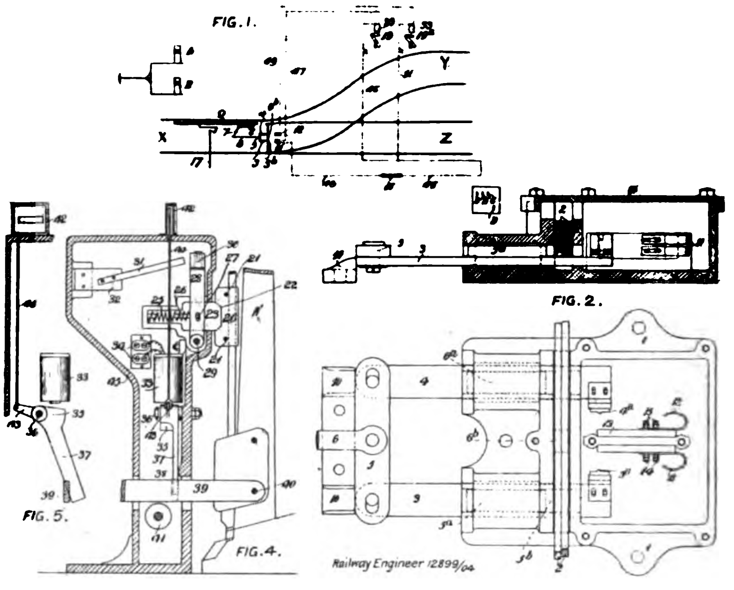
Relates to self-contained spring buffers for converting dead buffered vehicles into spring-buffered vehicles. Before applying the spring buffer the projecting end of the sole bar is cut off level or nearly level with the headstock, and the buffer packing-piece removed. The buffer case or guide is formed



of two parts A, A¹, pressed out of sheet steel, and provided with stiffening webs B, flanges C, and a bell-mouthed end D flanged over as shown. A reduced portion of the buffer plunger is passed through the back plate H and secured by a cotter K. Two lugs H¹ are so formed on the back plate as to fit above and below the sole bar end, to which they are secured by a bolt. Bolts M¹ M² also secure the plate H to the headstock and sole bar. In a modified arrangement the buffer case is cast in one piece and secured to a back plate H, or securing lugs may be cast integral with the chamber or case. (*Accepted 20th April, 1905.*)

Points and Signals. *12,899. 7th June, 1904. C. Dutton, Tolladine Road, C. H. W. Edmonds, Albert Road, and McKenzie and Holland, Ltd., Vulcan Iron Works, Worcester.*

This invention provides means for proving or detecting electrically, that switch points are in their correct positions and properly secured in that position by the locking bolts or plungers, and that the usual locking bar has been moved Two locking bolts or plungers 3, 4 are provided for each pair of points, one for locking the points in their normal position and the other for locking them in their reverse position. These plungers are pivotally connected at one end to a sway beam 5, and their other ends are adopted to engage their respective notches in the usual split stretcher-bar 2, electric contacts 3*a* 4*a* being arranged in the plungers 3, 4, and co-operating with spring contacts 11, 12, connected with a battery 18 and electric locking and indicating devices 19, 19*a*. A clip 20 fig. 4 is provided with a notch 22 on its inner edge, with which a tappet lock 23 is adapted to engage, the tappet lock working in a housing and being normally pressed outwards, into position to engage the notch or recess 22, by means of a spring 25. As shown the tappet lock 23 is provided with a pin or projection 26 about which spring 25 works.

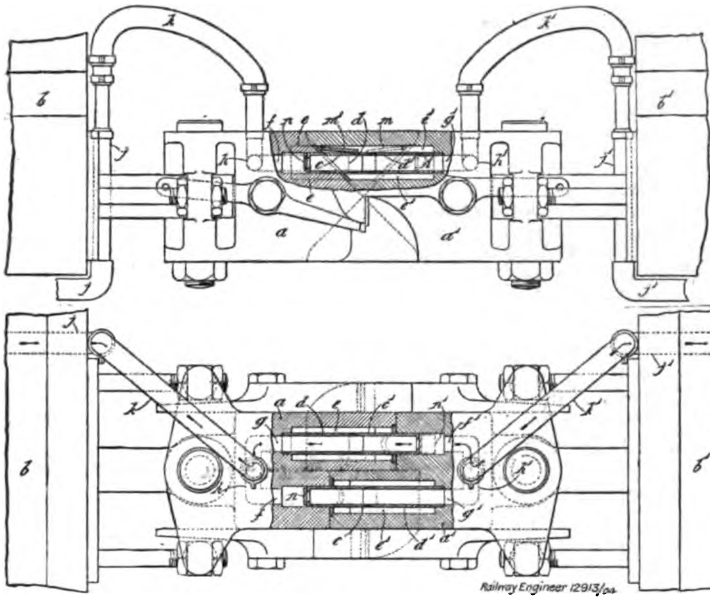


A stud 27 on the tappet lock 23 engages in a slot in the lever 28 pivoted at 29, the lever 28 carrying at its upper end a metal contact piece 30, which, when the lever 28 is operated, makes contact with a pair of springs 31 which are connected with the circuit wires in any convenient or known manner, the springs 31 being mounted on an insulating support 32. 33 is an electro-magnet connected to the circuit wires and battery 18 through terminals 34, the armature 35 of the magnet being pivoted at 36 and provided with a locking arm 37 which, in the normal position, when the magnet 33 is deenergised, engages a notch 38 in the tappet 39 which is pivoted at 40 on the lever A¹. 41 is a guide roller or support for the tappet 39. 42 is an indicator which is operatively connected to the short arm 43 of the armature 35 by means of rod 44. 45 is the casing in which the parts are mounted, the casing being itself mounted on or adjacent to the interlocking frame. D fig. 1 is the lever in the interlocking frame for operating the switch points. (*Accepted 13th April, 1905.*)

Brake Pipe Couplings (Automatic). *12,913. 7th June, 1904, G. J. Coles, 155, Dunsmuir Grove, Gateshead, Durham.*

According to this invention brake pipes are automatically coupled by the act of coupling the vehicles together. The coupling parts are provided with sockets *c c*¹ and spigots *d d*¹ disposed in recesses *e e*¹, and communicating with bifurcated passages *h h*¹, to which the train pipes are connected by flexible connections *k k*¹. Flap valves *m m*¹ are seated in the recesses *e e*¹ and normally kept closed by the pressure of air in the brake pipes, but are adapted to be engaged and

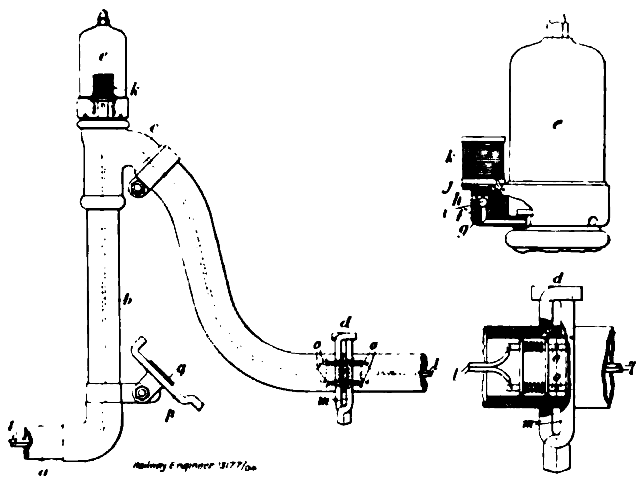
opened by the sockets c c^1 as they pass into the recesses when the coupling parts come together. Valves n n^1 are also provided on the ends of the sockets c c^1, these valves being arranged to open inwards and normally kept closed by the pressure of the air in the pipe, but opened when the coupling



parts come together, by the air released on opening the valves m m^1. The brake pipe coupling is shown combined with an automatic vehicle coupling made in accordance with Patent No. 19275/1903. (*Accepted 13th April, 1905.*)

Brakes (Pneumatic). *13,177. 10th June, 1904. The Consolidated Engineering Co., Ltd., Gotha Iron Works, Slough, Bucks, and H. E. Brown, Beachcroft, London Road, Norbury, Surrey.*

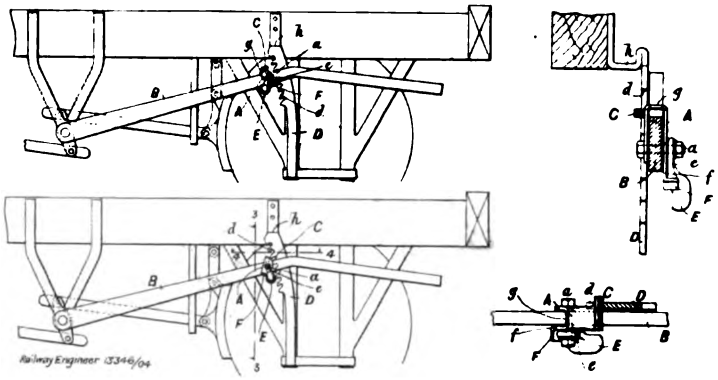
This invention relates to means for effecting the rapid and simultaneous application of air pressure or vacuum brakes throughout a train, and consists in combining with rapid action valves *e* fitted at intervals in the train pipe, small, electrically-operated supplementary valves *f*, adapted to



admit a quantity of air insufficient alone to actuate the rapid acting valves, and providing a practically simultaneous and instantaneous light application of the brakes for service working. The valve *f* has a seating for a ball *h*, held in a cradle *i* on the armature *j* of an electro-magnet *k*. The magnet *k* is in a circuit *l*, passing through the train pipe and coupled by spring contact pins *o*. (*Accepted 13th April, 1905.*)

Brakes (Wagon). *13,346. 13th June, 1904. E. J. Hill, 11, Victoria Street, Westminster.*

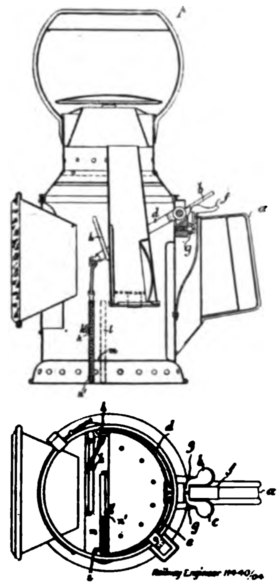
This invention consists in providing the hand lever of a brake with a pawl, so constructed as to be capable of being instantly thrown into or out of operation, so that the lever may be used either as a free lever or a locking lever. The pawl is in the form of an inverted U-shaped shackle A straddling the lever and pivoted on a bolt *a*. It is held in the operative or inopera-



tive position by a counterweighted lever E, which can be turned about the pivot bolt *a* and caused to bear against either side of a projection *f* on the shackle. A nose C is adapted to engage the rack D when the pawl is in the operative position. (*Accepted 13th April, 1905.*)

Hand-Signal Lamp. *11,440. 18th May, 1904. V. J. Feeney, 60, Queen Victoria Street, London.*

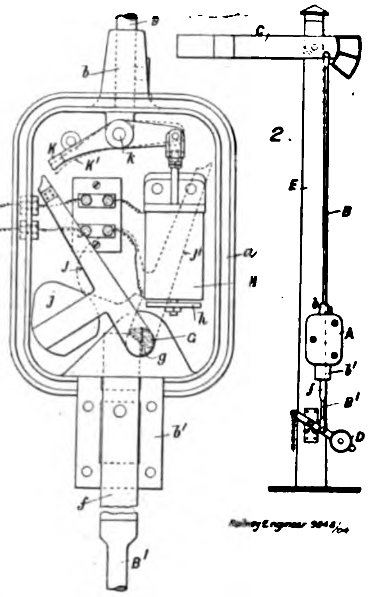
This invention has reference to a tri-colour hand signal lamp in which the change of colour is effected by coloured transparent discs, which are normally at the bottom of the lamp out of the range of the flame, and are brought successively in front of the flame by the depression of thumb-pieces to the right or left of a handle which is placed at the back of the lamp. The lamp may be arranged with a channel at the bottom into which the discs may drop, so as to keep them clear of the flame without unduly reducing their diameter. The thumb-pieces operate curved levers pivotted about a horizontal axis, and connected by links at their further ends with frames carrying coloured discs, these frames being pivotted to opposite sides of the lamp. Between the two thumb-pieces is a spring thumb-piece under which either of the thumb-pieces operating the discs may be placed. For the purpose of preventing an ambiguous signal from being accidentally given a transverse rocking lever is so pivotted opposite the spring thumb-piece that the depression of either thumb-piece operating the signal disc rocks the lever and raises the end which is below the other thumb-piece so that the latter thumb-piece cannot be depressed so to bring its disc before the light without simultaneously operating the former thumb-piece and dropping the former disc. (*Accepted 6th April, 1905.*)



Signals. *9,848. 29th April, 1904. W. R. Sykes, Cedar Lea, Park Hill, Bickley, Kent.*

The operation of the signal is made dependent upon permision from a source other than the operator who directly actuates the original operating mechanism, and the signal returned to "danger" independently of any corresponding movement of the actuating lever in the signal cabin, through the medium of an electrically controlled thrust coupling adapted to render either operative or inoperative as regards one member, movement in the direction of the member communicated to the other member of the coupling. A weighted casing *a* is connected to the upper part B of the thrust rod,

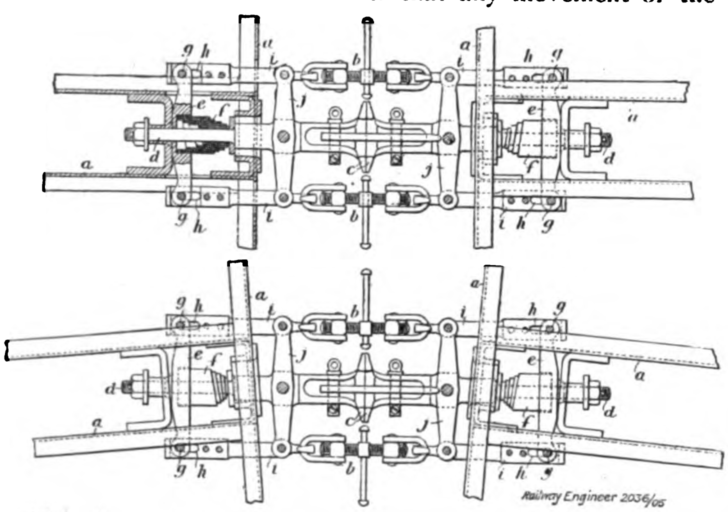
which constantly tends to descend to raise the arm C to "danger." The lower part B^1 is rendered operative or inoperative according to the position of a stop G, which is held in the path of the sliding bar *f* by an electrically controlled trigger K co-operating with an arm J, thus allowing B^1 to



raise B, or left free so that it can move aside, allowing the rod B^1 to rise without operating rod B. Or the part B can descend and return the signal to "danger" without the part B^1 being lowered. (*Accepted 6th April, 1905.*)

Draw and Buffing Gear. *2,036. 1st February, 1905. F. T. Millard and M. M. Lindsley, North Western Railway, Rawalpindi, India.*

In flexible draw and buffing gear a washer lever *e* is introduced behind the draw spring *f* and connected to the couplings on either side in such a manner that any movement of the



vehicle from the straight line pulls the lever *e* on one side, compressing the draw and buffing spring. Slots are provided in the underframes to allow of the free movement of the levers and draw bar. (*Accepted 6th April, 1905.*)

SPECIFICATIONS PUBLISHED.

A.D. 1904.

8393. Locking nuts, bolts, &c. Marshall.
8519. Train pipe couplings. Boirault.
8571. Railway and tramway points. Toogood.
9378. Tablet, train staff and like systems for working traffic on single lines. Edmonds, McKenzie and Holland, Ltd.
9848. Signals. Sykes.
11052. Points and crossings for railways or tramways. Brown.
11074.—11077. Railway or tramway signalling systems. British Thomson-Houston Co., Ltd. (General Electric Co.)
11440. Tricolour hand-signal lamp. Feeny.
11801. Signals. Pinder.
11842. Apparatus for lighting railway vehicles by electricity. Wright.
11954. Water level indicators for tenders of locomotive engines. Wright.
12608. Bogies for railway vehicles. Timmis.
12778. Central buffers and couplings. Johnston.
12899. Point and signal apparatus. Dutton, Edmonds, and Mackenzie and Holland, Ltd.
12913. Couplings. Coles.
13177. Automatic vacuum or air pressure brakes. Consolidated Engineering Co., Ltd. and Brown.
13346. Wagon brakes. Hill.
13520. Apparatus for washing carriages, &c. Campbell and Campbell.
13635. Compound locomotives. Smith.
13914. Wagon axle boxes. Eley and Nawthrop.
14077. Fog-signalling apparatus. Thomas.
14318. Vacuum brake apparatus. Cloud.
16039. Fog signals. Smith.
20039. Apparatus for operating tramway points from the cars. Booth.
21169. Permanent way rails. Perry.
21642. Electrical apparatus for adjusting tram rail points from the car. Macaulay.
22965. Rail chairs. Young and Studd.
26472. Vacuum brakes for railway and like vehicles. Cloud.
26634. Buffers. Gatwood and Willans.
28486. Tram and vehicles tracks for roads and bridges. Gibbon.

A.D. 1905.

874. Hand lever for moving wagons, &c. Michel.
2036. Flexible draw and buffing gear. Millard and Lindsley.
2922. Triple valves for air brake systems. Allison (Levy.)
6038. Means for locking the rocking-head on transition couplings. Fried. Krupp Akt. Ges.

Electrically Operated Carriages; Metropolitan Railway.

(*Continued from p. 143.*)

In our April issue we published the drawings of the bodies of the new carriages for the electric working of the Metropolitan R., and in our issue for May those of the underframes, and we now publish the drawings of the bogies together with some further details of the method of supporting the motors and of the brake. For these last we have to thank the Westinghouse Brake Co.

The bogies were all built by the Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd., of Birmingham, under the supervision of Mr. Ingram, carriage and wagon superintendent, and to whom we are indebted for the drawings. The whole of the electrical equipment was supplied by the British Westinghouse Manufacturing Co., London and Manchester. In general design the motor and trailer bogies do not differ widely, though, of course, the former is stronger and stiffer. Both are constructed of pressed steel plates, the dimensions of which are figured on the drawings figs 1 and 2. The quality of the steel and the tests which it had to pass were the same as those given in our May issue for the underframe steel.

The method of attaching the bar to which the collector or shoe is attached is also clearly shown. The feature of the motor bogie is the method of carrying the motors, which are spring suspended quite independently of the bearing springs. The arrangement is shown by fig. 4 (and by dot and dash lines on fig. 2), and consists of two beams connected at the ends to cross beams which are suspended on springs from a bracket cast on the motor casing resting directly on the axles. The motors are supported on the beams.

The brake gear was supplied by the Westinghouse Brake Co., and is of their "quick acting" type. The general arrangements for the motor and trailer carriages are shown by figs. 5 and 6.

The pump or compressor is suspended from the underframe, and an outside view of it is given by fig. 7. It was specially designed for producing the compressed air required to operate the Westinghouse quick-acting brake and the electric multiple control system in use on the Metropolitan R.

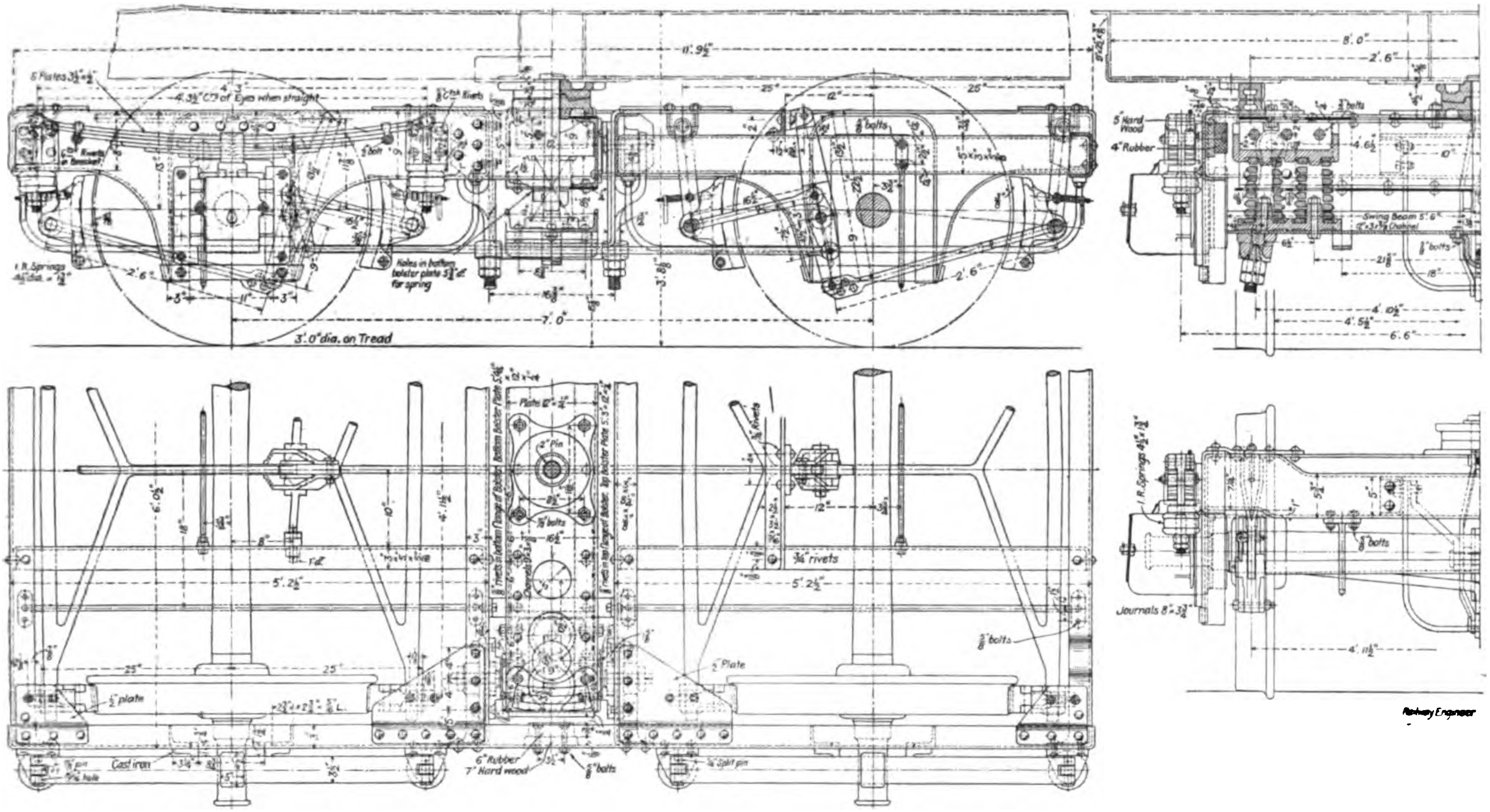


Fig. 1.—Trailer Car Bogie, Electrically-Operated Carriages; Metropolitan Railway.

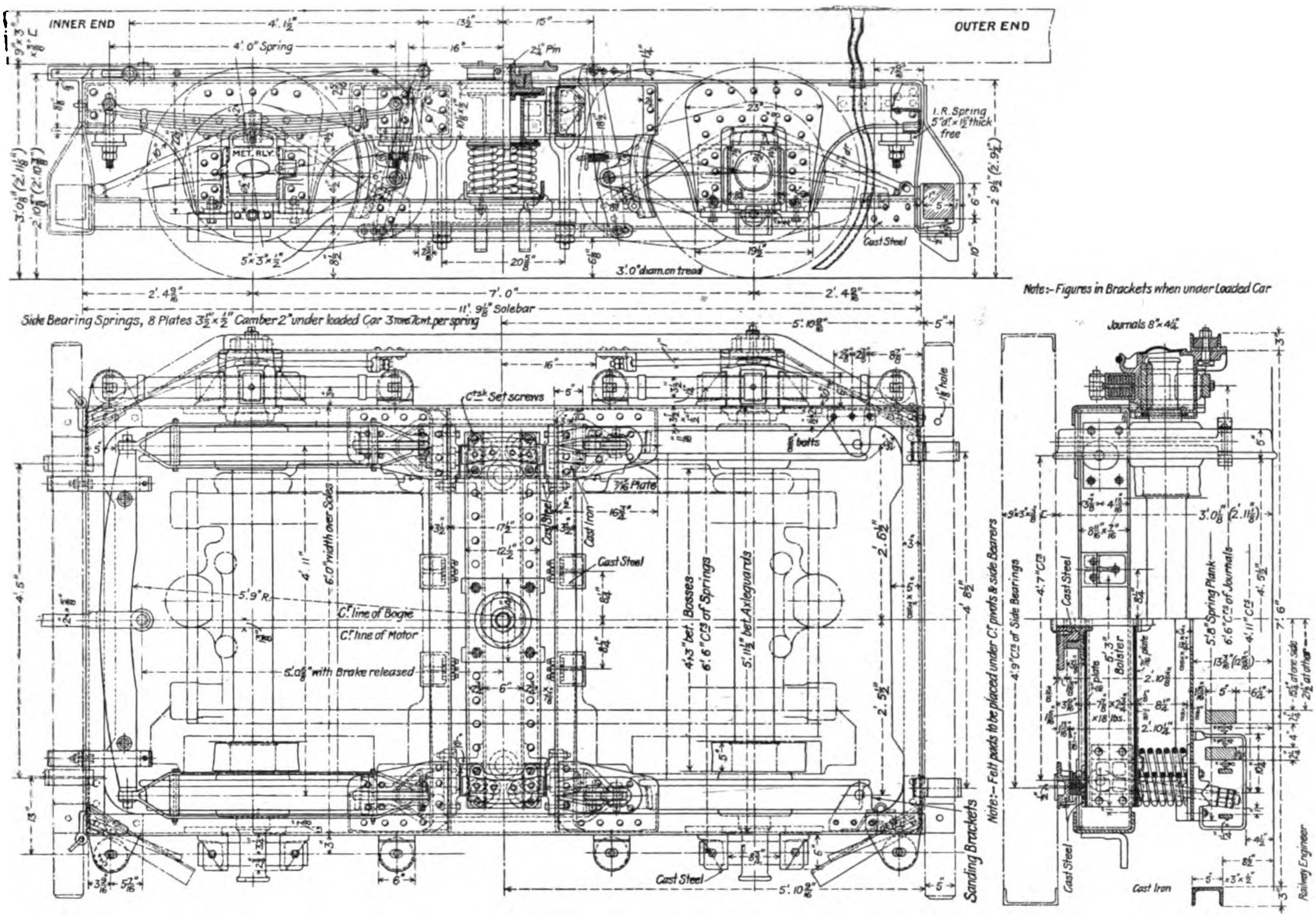


Fig. 2.—Motor Bogie, Electrically-Operated Carriages; Metropolitan Railway.

The motor is of the well-known dust proof, series wound, consequent pole type, operating on a circuit of 600 volts, supplied with ample bearings, self oiled. It is connected direct to the air pump, the crank forming part of the armature shaft, which is connected to a sliding block operating in a yoke rigidly attached to the piston. The main bearing of the pump is of a substantial construction to withstand hard wear, and is self-lubricated from an oil well by means of a ring. The sliding block is arranged with a plunger end operating in an oil dash pot, formed on the yoke; this arrangement takes care of oiling the slide block and crank pin.

The pump has both revolving and reciprocating weights fully balanced, and works practically noiselessly and without vibration.

All working parts have been made interchangeable, and have been so arranged that they can be got at easily for repairs and renewal.

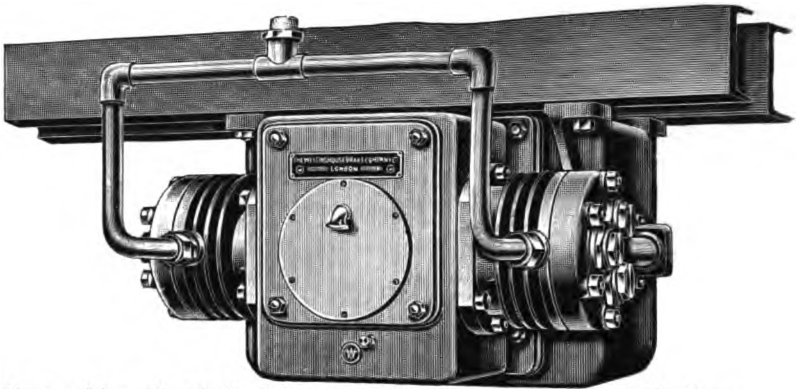


Fig. 7.—8 h.p. Electrically-Operated Air Compressor, suspended from Car Frame.

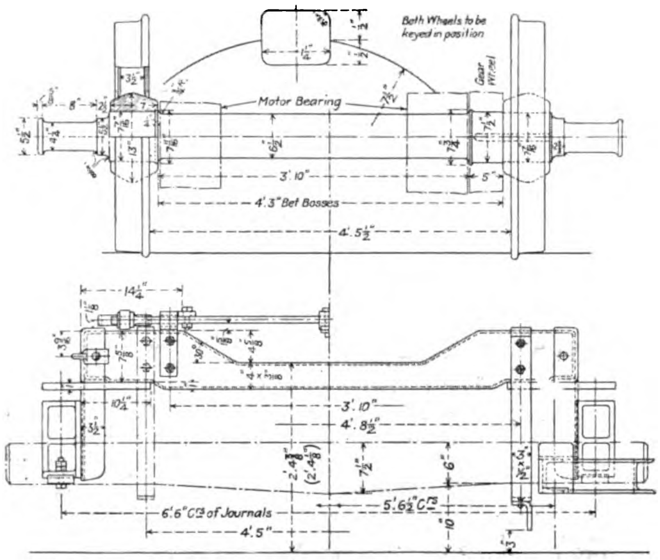
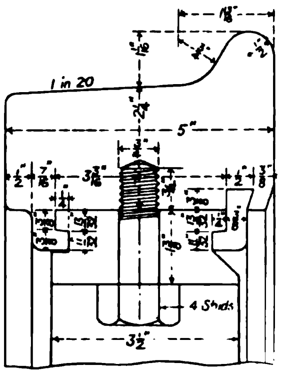


Fig. 3.



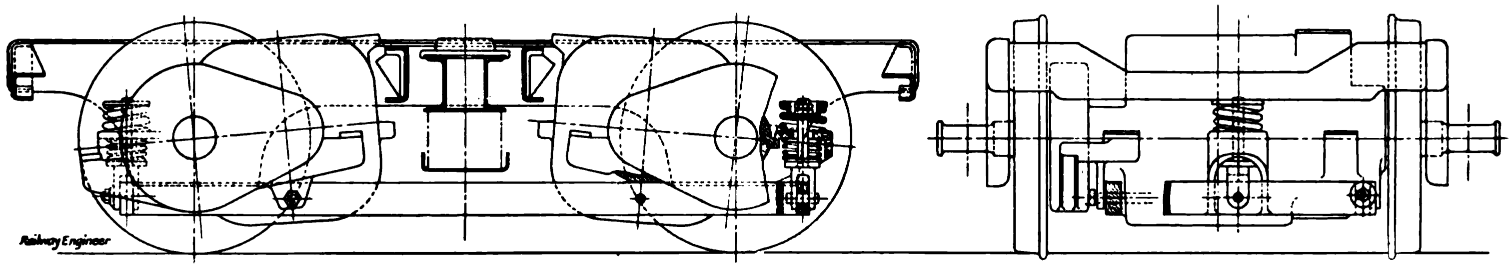


Fig. 4.—Method of Carrying Motors.

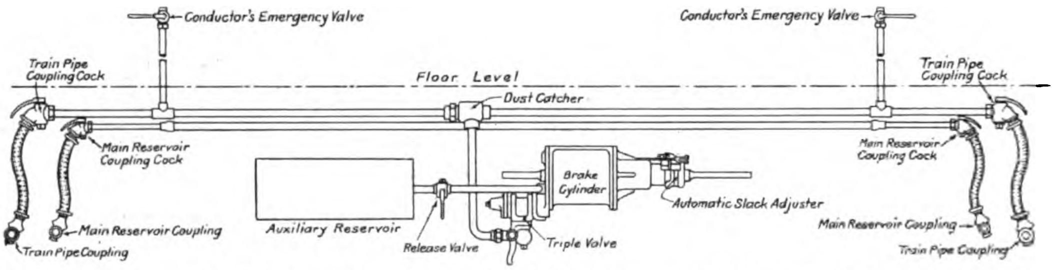


Fig. 6.—Diagram showing Parts and Connections of Westinghouse Automatic Quick Acting Brake on Trailer Car.

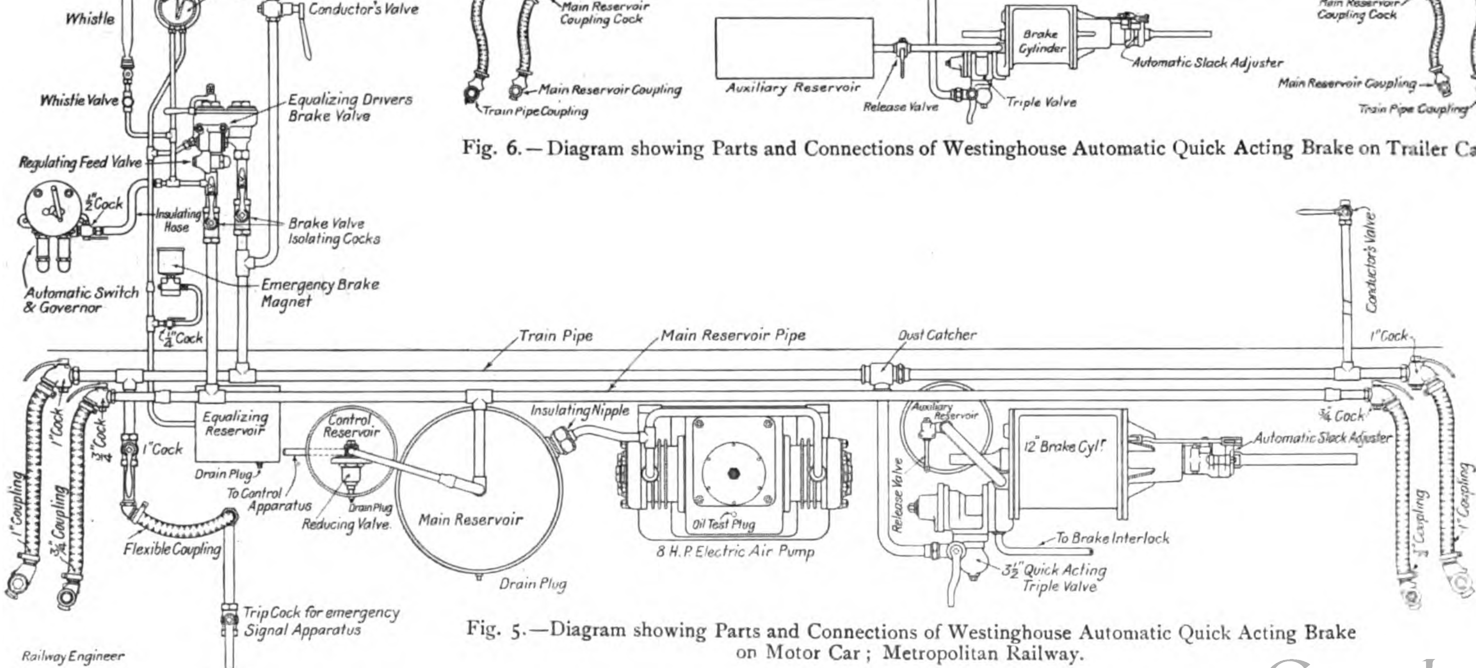


Fig. 5.—Diagram showing Parts and Connections of Westinghouse Automatic Quick Acting Brake on Motor Car; Metropolitan Railway.

The valves are designed so as to give as little clearance as possible, thereby giving a great efficiency in output, and they are so arranged as to be readily withdrawn from the head for examination purposes when required.

The speed of the pump is 250 r.p.m., and when compressing to 90 lbs. per square inch it will deal with about 38 cub. ft. of free air per minute. It is automatically controlled by means of an electric switch and governor, by which the motor is cut out of circuit when the pressure in the main reservoir has reached the maximum to which the governor is set, and is cut into circuit again when the pressure has dropped to the minimum to which the governor is also set.

Superheaters in Locomotives on the Belgian State Railways.*

By Mons. J. B. Flamme, Inspector-Général de l'Administration des Chemins de Fer de l'Etat Belge, Brussels.

The Belgian State Railway has recently put in service a series of simple expansion locomotives, the boilers of which carry a pressure of 14 atm. (205·8 lbs. per sq. in.), with an inside diameter of 1·600 m. (5ft. 3 ins.), while that of the cylinder is 520mm. (20½in.). This class of engine gives the maximum power obtainable by the simple expansion of steam. In fact every new enlargement of the cylinders would demand larger dimensions for the crank-axle and moving parts; on the other hand, the necessity for clearing the loading-gauge limits the diameter of the boiler; in short, with simple expansion it would be difficult to utilise steam with a pressure exceeding 14 atm.

Under these conditions and in view of further increasing the power of the engines it becomes necessary to resort to some other system for increasing the useful work of the steam without enlarging the existing boilers.

The two solutions under consideration are compound working and superheating of the steam. The first of these does not strictly come within the limits of this paper.

Arrangements for producing superheated steam and the results obtained with a system that has been in service for more than a year will now be considered.

Schmidt Superheater for Simple Expansion Locomotives.

For some time the Locomotive Department had their attention drawn to the favourable results obtained by using superheated steam in industrial stationary engines. By superheating the theoretical cycle is improved, and the pressure is maintained The volume of steam is augmented proportionately to the rise of temperature, diminishing, however, its density. In other words, when the degree of superheat is sufficient to prevent the loss due to condensation in the cylinders, then the surplus heat contained in superheated steam is sufficient to reheat the walls of the cylinders, maintaining the temperature necessary to get rid of the condensation and the loss of work during expansion. These trials have brought to light a valuable property of superheated steam. It was recognised as a bad conductor of heat, contrary to that which obtains when steam is in the saturated state.

These numerous advantages, tested by many trials undertaken by most competent engineers, are specially valuable to the locomotive engine. The employment of a practical superheater augments the power of the boiler, and the utilisation of superheated steam is most economical. This is well observed in hauling heavy goods trains on sections of the line having heavy gradients. For it is then indispensable to reduce to the minimum the consumption of water and steam. For the suburban trains having frequent stoppages superheat is again highly recommended, because it reduces the condensation necessitated by the frequent stops. High speed is also favourable to the employment of higher superheated steam, the great fluidity of which, as well as its dryness, permit running with early cut-offs, which helps the boiler just at the time when it is most hard pressed.

On the other hand, the passage of saturated steam through the pipes (and steam ports) is more difficult, and entails inevitably an increase of condensation. Having in mind these various theoretical and practical considerations the administration of the Belgian State recognised the great utility of pushing on their investigations in this direction.

It was in 1900 that the administration of the State Railways opened negotiations with M. Schmidt, the German expert, who at that period had already introduced some locomotives with steam superheaters formed principally of a series of rings placed in the smoke-box.

This last plan, described in most of the technical newspapers, and applied to a Prussian State locomotive shown in Paris in 1900, adapted itself without difficulties to outside cylinder engines.

It is not quite the same for inside cylinder engines which, as in England, are generally used in Belgium. In this case it becomes impossible to clear from the bottom of the smoke-box the cinders brought by the large flame-tube placed at the base of the barrel.

On the other hand, a superheater, established in the barrel of the boiler and described later (fig. 5) offers some real advantages. It is lighter, less cumbersome, easy to clean and maintain, and its introduction does not necessitate any important modifications in the smoke-box. Consequently it was this kind of apparatus that the Locomotive Department adopted in a new type of powerful locomotive then being built in the Cockerill Works at Seraing.

At the same time another important question presented itself. Was it absolutely necessary to superheat the steam to a temperature reaching 300° to 350° C. (572° to 662° F.)? It is evident that the more the steam is superheated the more necessary it becomes to give attention to the oiling of the piston-valves and cylinders and to the construction of the stuffing-box. With a view to getting a clear idea of the actual amount of superheat some trials were made with a superheater of small surface installed in the barrel of one of the locomotives, type 35, which will be described later. After several months of experiments it has been recognised that the utilisation of steam slightly superheated does not offer any appreciable economy of fuel or increase of power.

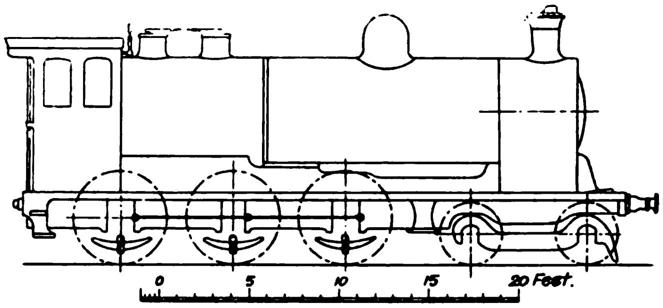


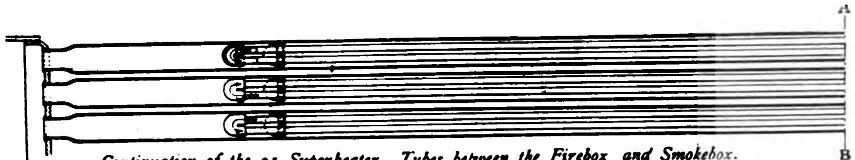
Fig. 1.—Six Wheels Coupled Locomotive; Belgian State Railway.

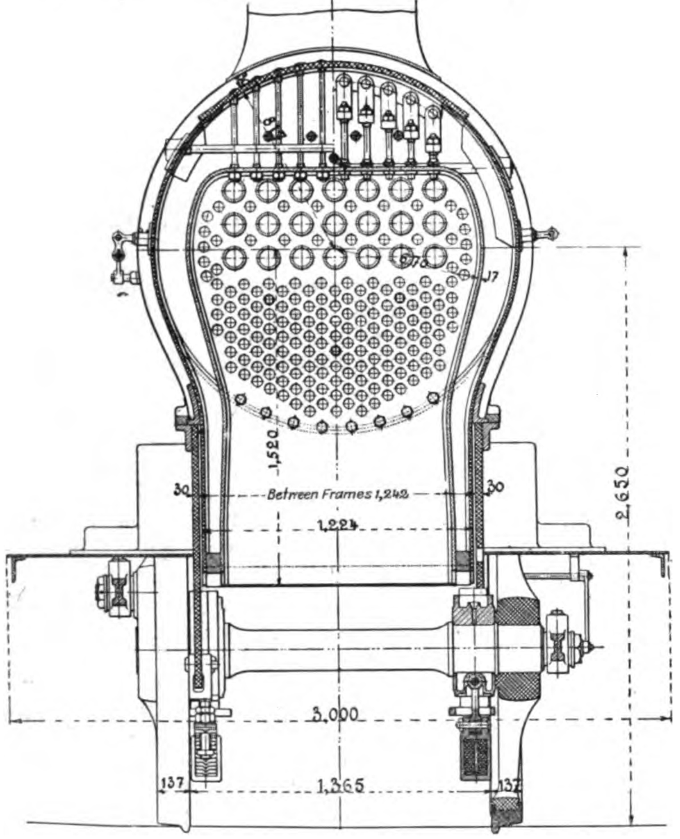
On the other hand, with the Schmidt apparatus placed on a locomotive, type 35, figs. 1 to 4, and provided with steam with a temperature varying between 300° and 350° C. (572° to 662° F.), some favourable results have been obtained.

The locomotives compared, one using saturated steam and the other superheated steam, are both of type 35, with six coupled wheels of 1·600m. (5ft. 3ins.) with bogie in front. The boiler has a round-topped fire-box, the roof of the furnace being connected to the arch by vertical stays. The fire-box, of a medium depth, burns coal with briquettes varying in quantity with the weight of the trains. The inside cylinders are made with piston slide-valves placed above, steam being admitted in the middle of the valve. This arrangement, with the Stephenson valve-gear, involves the employment of a rocking-shaft, which reverses the position of the valves compared with those having the exhaust port in the middle of the piston-valves.

The six coupled wheels and the bogie are fitted with compressed-air brakes. The engine is illustrated in figs. 1 to 4.

*Read before the Institution of Mechanical Engineers at Liége, June, 1905.





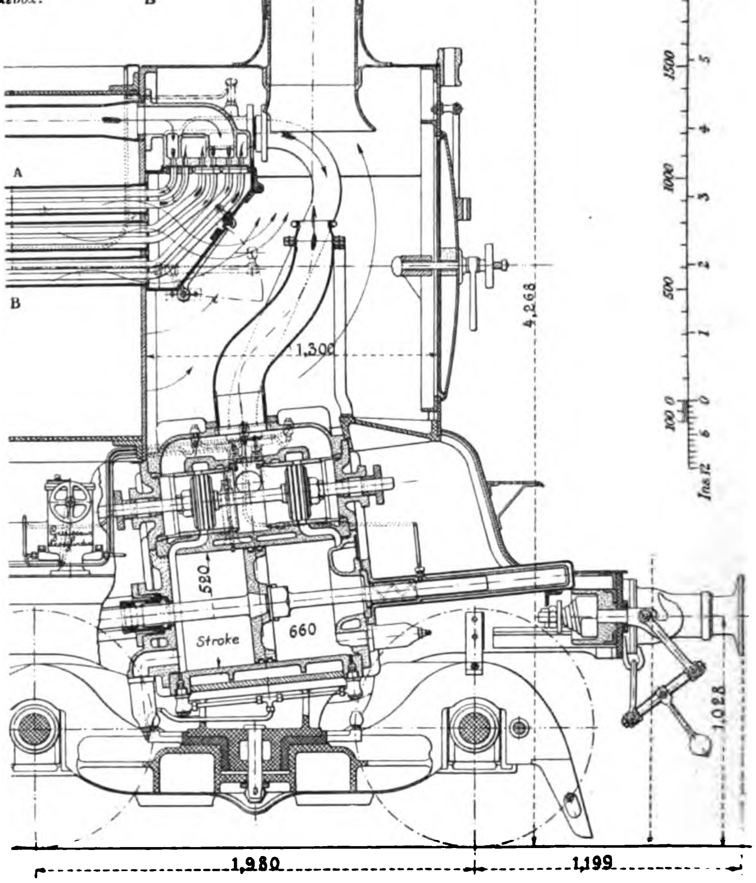


Fig. 4. Fig. 2.
Six Wheels Coupled Locomotive, fitted with Schmidt Superheater; Belgian State Railway.

The principal dimensions are given in the following table:—

Cylinders:—	
Diameter	520mm. ($20\frac{1}{2}$ins.)
Stroke	660mm. (26ins.)
Working Pressure	14atm. (205·8lbs. per sq. ft.)
Diameter of driving wheels ...	1·600m. (5ft. 3ins.)
Height of centre of boiler above rail	2·650m. (8ft. $8\frac{1}{16}$ins.)
Tubes:—	
Length	4·130m. (13ft. $6\frac{1}{2}$ins.)
Exterior Diameter	50mm. ($1\frac{15}{16}$ins.)
Number...	271
Heating surface:—	
Tubes, internal	158·25 m². (1,703 sq. ft.)
Fire-box	14·90 m². (160 sq. ft.)
Total	173·15 m². (1,863 sq. ft.)
Grate surface	2·84 m². ($30\frac{1}{2}$ sq. ft.)
Weight in running order:—	
1st axle...	9,740 K. (9.5 tons).
2nd „	9,740 K. (9·5 tons).
3rd „	18,215 K. (17·9 tons).
4th „	17,850 K. (17·5 tons).
5th „	17,500 K. (17·5 tons).
Total weight	72,965 K. (71·8 tons).
Adhesion weight	53,565 K. (52·7 tons).
Tractive effort $p\,d^2\,l/D=$	16,128 K. (15·8 tons).

The engine provided with the Schmidt superheater has less heating surface than the above, owing to the substitution of 21 tubes of 118 mm. ($4\frac{5}{8}$ ins.) diameter for 103 tubes and 50 mm. ($1\frac{15}{16}$in.). For this locomotive the internal heating surface in the tubes is 98·10 m.² (1,056 sq. ft.) and the total heating surface is 130·056 m.² (1.400 sq. ft.).

The exterior superheating surface is equal to 27·15 m.²

The superheater proper is illustrated in figs. 2-4, and consists essentially of two parts.

(1) A series of iron tubes of 118 mm. ($4\frac{5}{8}$ins.) external diameter, occupying the upper part of the nest of tubes and offering like them a passage for flame and hot gases.

(2) Some U shaped tubes grouped in pairs among the flame tubes and used for the circulation of the superheated steam.

A steam collector in several divisions is placed on the top of the smoke-box. Some supplementary parts complete the system.

There must also be a diaphragm to close the flame tubes when steam does not circulate in the superheating tubes. This diaphragm is handled by the aid of a lever near the engine driver.

A mercury thermometer shows the temperature of the superheated steam at the entrance of the steam-pipe. The degree of superheat is read on a graduated quadrant placed in the cab.

The large flame-tubes, which are of solid drawn iron, are screwed into the fire-box tube-plate and expanded in the smoke-box tube-plate.

The superheating tubes, also of solid drawn iron, are protected against the action of the flame at the fire end by cast-steel caps.

In the smoke-box these tubes are expanded into flanged bushes fixed by bolts. The tightness is assured by means of asbestos joints.

Copper, bronze and brass are usually excluded from all parts that come in contact with the superheated steam. For this reason the steam pipes are of iron, and the joints between these pipes and the cylinders are formed with cast-iron flanges.

The metallic packings of the piston-rods and valve-spindles are composed of cast rings and white metal, the contact of which on the rod is obtained by a spring permitting small side movements of the rod.

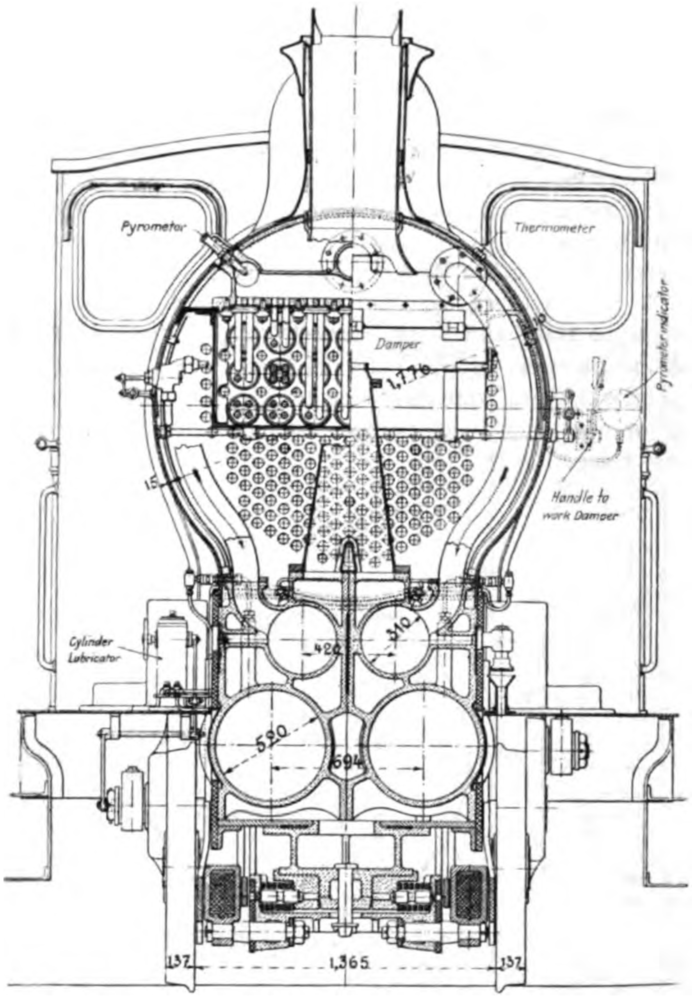


Fig. 3.—Six Wheels Coupled Locomotive: Belgian State Railway.

The slide-valves are cylindrical with steam admission in the middle of the valve, which reduces the packing to simple bronze rings with lubricating grooves. The slack between each valve and the cylindrical chamber against which it rubs is closed by means of three cast-iron rings of suitable section, the steam pressing on the interior of the principal segment.

The oiling of the cylinders and valves is done by a lubricator in six sections. The lubricant used is a mineral oil with a high flash point.

The trials of these two locomotives took place with goods trains of accelerated speed and local passenger trains running on the Luxemburg line, the extremely undulating profile of which contains many inclines of 16 per 1,000.

Each locomotive worked twenty-four goods trains weighing 250 t. (246 tons) and twelve passenger trains weighing an average of 150 t. (147·6 tons). The total journey made by each engine amounted to 11,500 kilometres (7,146 miles). The saving of coal per train-kilometre in favour of the superheated-steam engine was found to be 13·33 per cent., and the water comsumption was reduced 18 per cent. On the other hand, the expenses of lubricating increased in a fixed proportion.

After four months of trials on the Luxemburg line, more precise experiments were organised with the through passenger trains on the Brussels and Charleroi line, which has a series of inclines of 13 per 1,000. For ten days, during which the climatic conditions remained invariable, these two locomotives hauled alternately the same train of 250 t. (246 tons). The saving in favour of the superheated-steam locomotive amounted to 12·5 per cent. for fuel and 16·5 per cent. for water. Moreover the speed raised at the top of the incline showed an average increase of 9·5 per cent., all the conditions being exactly the same.

As regards maintenance the superheated-steam locomotive, type 35, has not required special attention during its $1\frac{1}{2}$ year's service.

These early favourable results have led to the Belgian State Railway venturing on the application of superheat to locomotives on a larger scale. With this in view twenty-five locomotives, comprising five different types, all provided with the Schmidt superheater described above, are actually in course of construction or are about to be put to work.

Amongst these last are a certain number of locomotives of type 35, which have fully confirmed the favourable results obtained by the first engine of this kind.

Among the number of services actually and successfully run by these engines is to be particularly noted the hauling, from Brussels to frontier, of express trains going to Paris. These trains, whose tare weight of vehicles exceeds 340 tonnes ($334\frac{3}{8}$ tons), surmount the 17 kilometres (10·56 miles) separating Mons and the frontier in 17 minutes, against a continuous up grade with inclines varying from 1 in 125 to 1 in 55.

Cockerill Superheater for Compound Locomotives.

It is seen from the preceding that it is now known that superheated steam as applied to locomotives is susceptible of giving remarkable results which come within the domain of practice. The State Railway has decided to persevere with their experiments in combining superheat with compounding, because they perceive that there is a most interesting question to elucidate.

Is it more economical to divide the superheater into two parts in such a manner as to raise the temperature at the entrance to both the H.P. and the L.P. cylinders, or, on the other hand, to devote the whole power of the apparatus to superheating the steam before it enters the L.P. cylinders? The Cockerill Company, after numerous investigations, have just completed a superheater that will enable them to settle this question.

This entirely new system is being continually tested on a series of compound engines, with four cylinders, and six-coupled wheels of 1·80 m. diameter (5ft. 10ins. diameter) with a bogie. This locomotive, called 19*bis*, possesses a boiler having an interior diameter of 1·65 m. (5ft. 5ins.) diameter, and is pressed to 15·5 atm. (227lbs. per sq. in.). The H.P. cylinders are inside and connected to the leading coupled-axle; the L.P. cylinders are outside and drive the second axle. The four cylinders are placed on the transverse axis of the bogie. The two valve motions of the Walschaert type are outside. They present several peculiarities due to the employment of cylindrical valves, with the steam introduced in the middle. The leading dimensions of the engine, type 19 *bis*, are shown in the table below.

Diameter H.P. cylinders	= 0·36	($14\frac{3}{16}$ins.)
,, L.P. ,,	= 0·62	($24\frac{13}{32}$ins.)
Stroke	= 0·68	($26\frac{25}{32}$ins.)
Initial pressure	= 15·5 atm.	(227lbs. per sq. in.)
Diameter of driving wheels	= 1·80 m.	(5ft. 11ins.)
Height—		
Rail to centre of boiler	= 2·80 m.	(9ft. $2\frac{3}{8}$ins.)
Tubes—		
Length of	= 4·0 m.	(13ft. $1\frac{1}{2}$in.)
Number and outside diameter	= 30 of 107 mm.	($4\frac{7}{8}$ins.)
	= 219 of 50 mm.	($1\frac{31}{32}$in.)
Heating surface—		
Interior of tubes	= 157·62 m^2.	(1,696·6 sq. ft.)
Of fire-box	= 18·35 m^2.	(197·5 sq. ft.)
	175·97 m^2.	(1,894·1 sq. ft.)
Area of grate	3·01 m^2.	(32·3 sq. ft.)

The apparatus for superheating the steam may be used in two ways. One may heat the steam near to the entrance to the H.P. cylinder, and afterwards near to those of the L.P. cylinders, or at the entrance to the L.P. only. The superheater shown in fig. 5 (page 9) indicates the general arrangement, comprising two series of large flame tubes containing the circulating pipes intended to superheat the steam.

The role of the compartments *C* and *H* is placed inside the barrel, and of the collectors *J* and *D*, installed in the smoke-box, will be dealt with later on in connection with the explanation of the working of the apparatus.

In B there is a valve with three pistons intended to divert the steam coming from the regulator towards the compartment C, or into the tube L, according as it is required to operate the superheat to H.P. and L.P. or to L.P. only. The movements of the valve B are automatically repeated, thanks to the presence in the tube L of an identically similar valve located within B^1. The destinations of the different pipes is made clear by following the course of the steam as explained below.

First Case.—Superheat at the entrance of H.P. and L.P.—The steam on leaving the regulator A makes its way, after passing B, towards the compartment C; from there it traverses the left set of superheater tubes and enters the collector D, whence it goes to the H.P. cylinders by passing through the valve B^1 and pipes E.

The superheated steam, after doing the work in the H.P. cylinders, goes out by the exhaust pipe, traverses the valve B^1, after that the pipe G, lodged in the interior of the barrel to enable it to enter the compartment H. From there the steam goes into the superheating tubes (the right set), and arrives by the pipes K leading towards the L.P. cylinders.

Second Case.—Superheat at the entrance of the L.P. Cylinder.—The valve B is placed by the driver in a position that diverts the direction of the steam, directly from the regulator into the pipe L; from there it goes to the H.P. cylinders after having passed through the valve B^1 and the delivery pipes E. On leaving the H.P. cylinders the steam traverses the pipes F, the valve B^1, and enters into the collector D. From the front it passes back through the left set of superheater tubes and arrives at the compartment C. From this it passes through the valve B into the compartment H, and traverses through the right group of superheater tubes, whence it goes into the collector J, and from there by the delivery pipes K into the L.P.

A locomotive of type 19*bis*, showing this pattern of superheater, is exhibited in the Liége Exhibition. Trials are going to be continued with a second identically similar engine, to determine which is the more advantageous mode of working to adopt for the new superheater.

It is manifest that if the superheat is required at the entrance of the L.P. cylinders only, it will be possible to dispense with a certain number of parts of the superheater and by that means remedy the obstruction in the spoke-box.

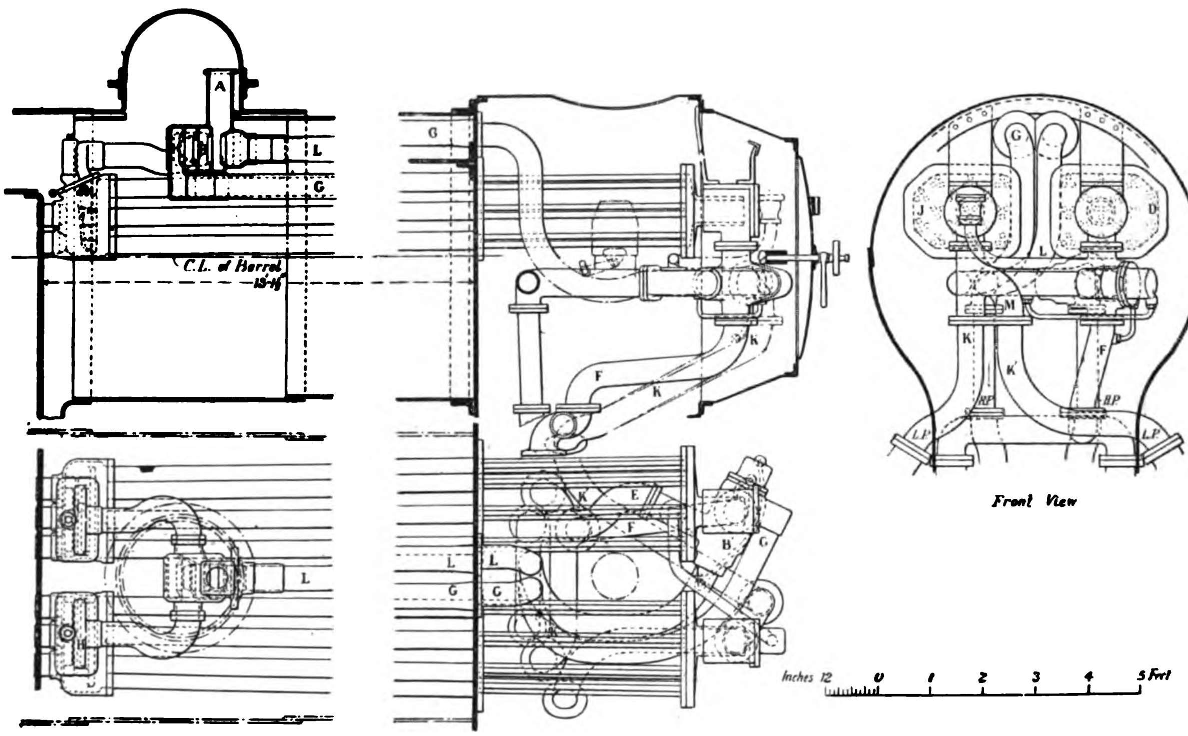


Fig. 5.—Experimental Superheater on a Compound Locomotive.

Railways and the Board of Trade.—V.*

(*Continued from p.* 146.)

All such occurrences, except broken tyres and axles, have to be reported on Form A, broken tyres on Form B, and broken axles on Form C. Copies of these three forms are annexed.

All accidents at level crossings to passengers, servants of the railway company and other persons, whether killed or injured, have to be reported with full detail on a special form, which for reference may be called Form D, and which is also annexed.

All these returns, accidents to trains and servants, and mishaps to road and stock, pass through the hands of the Assistant Secretary of the Railway Department and the Chief Inspecting Officer, who determine whether enquiries shall be held, or what further information shall be asked for from the railway companies.

As regards accidents to passenger trains, it may be taken that an enquiry is held in all cases where passengers are injured, or where there is revealed a breach of regulations, due to want of care on a servant's part or a lack of supervision on the part of officials.

Where the facts are quite clear and no good purpose can be served by an enquiry the case is dealt with by correspondence, or it is left to the inspecting officer to make some enquiries when next he is on the line concerned.

That only a percentage of the mishaps are enquired into will be seen by the following figures taken from the annual report for 1903:—

Year ...	1897	1898	1899	1900	1901	1902	1903.
Number of Accidents Reported—	188	168	291	299	276	223	235
Number of Enquiries Held—	48	58	66	64	44	37	31

Should an enquiry be ordered the company are not as a rule advised by the Board of Trade, and the first intimation they

* Nos. I., II., III., and IV. appeared in the *Railway Engineer* for January February, March and May respectively.

FORM A.

______________________ Railway Company.

RETURN directed to be made to the BOARD OF TRADE of ACCIDENTS (in compliance with the Regulation of Railways Act, 1871, Sect. 6).

Date of Accident and time of day at which it occurred.	Nature and Cause of Accident, and Place where it occurred; and if the Accident happened to a train belonging to a Company other than the Company owning or working the Railway, the Name of such Company.	Particulars of Damage to Trains or Works.	Particulars of Injury to Persons.					Servants of Companies.			REMARKS.
			Name of Person.	Nature of Injury.	Description, stating whether Passenger, Servant of the Company, or of Contractor (if a Servant, specify the class of Service to which he may belong), Persons crossing at Public or Private Level Crossings (specifying which) Trespassers, Persons on business at Stations, or other Persons.	Whether Accident occurred from Causes beyond the control of the persons injured, or from their own want of Caution, or Misconduct.	Copy of Verdict at Coroner's Inquest (if in England, Wales, or Ireland) or (if in Scotland) copy of Finding at Procurators, Fiscals or Sheriff's Enquiry should death have ensued.	Number of regular working hours per deim.	Number of hours injured person had been on duty when the accident occurred.	Whether person injured was over or under 18 years of age.	

FORM B.

RETURN OF BROKEN TYRES during the Month of ______________________ 189

Name of Railway.	Date of Fracture.	Description of Vehicle and Name of Owner.				Description of Tyre.							Particulars of Fracture.			Whether the Tyre or Portion of it left the Wheel.	Age of Tyre, and Number of Miles run when known.	Results of Fracture.	REMARKS. (State where the Fracture was discovered.)
		Vehicles belonging to Railway Companies.			Private Owners' Vehicles.	Description of Material.	System of Fastening or Name of Patentee.	Reference to Diagram or Sketch.		Original Thickness of Tyre.	Thickness at Period of Failure.	Diameter of Wheel.	Whether Fractured Transversely, at the Bolt-Hole, at the Weld or otherwise, or Split or Bulged Longitudinally.	No. of Pieces.	Whether showing Honeycomb-holes, Flaws or Cracks.				
		Engine or, Tender.	Passenger Vehicle.	Goods or Mineral Vehicle.				No. of Diagram or Sketch.	Reference to position of Fracture if Longitudinal.										

FORM C

RETURN OF BROKEN AXLES during the Month of__________, 189 .

Name of Railway.	Date of Fracture	Description of Vehicle, and Name of Owner				Description of Axle	Material, and Name of Maker	Position of Fracture	No. of Diagram	Letters showing the position of Fracture	Diameters				Length of Axle	Nature of Defects (State if fracture showed an old flaw or a brittle or crystallised appearance)	Age, and Mileage	Result of Fracture	REMARKS. (State in this column where the Fracture was discovered and whether the Vehicle was loaded or empty)
		Vehicles belonging to the Railway Companies.			Private Owners' Vehicles						At Journal	At Wheel Seat	At Centre	At Crank Journal					
		Engine or Tender	Passenger Vehicle	Goods or Mineral Vehicle															

Form D

______________ Railway

Accidents at LEVEL CROSSINGS.

Date and Time of Accident.	Place and Name of Crossing.	Nature and Cause of Accident.	Particulars of Damage to Train or Works.	Particulars of Persons Killed or Injured.				Particulars of Level Crossing.				Remarks.
				Name.	Nature of Injury.	Description.—Whether passenger, servant, or other person, and in the case of a servant, capacity in which employed.	In cases of Fatal Accidents, copy of Verdict at Coroner's Inquest, with rider or recommendation of Jury, or (if in Scotland) copy of finding at Procurator Fiscal's, or Sheriff's Enquiry.	Description.—Whether public or private road, or footpath.	Nature of Protection, showing whether gates, wickets and signals are provided, and whether gates are controlled by the signalman.	Whether there is a gateman in charge, and whether he has any other duties.	Whether the gateman warned the persons killed or injured, or in any other way endeavoured to protect them from danger.	

generally receive is the advice from the inspecting officer as to when he is coming.

On arrival, the officer generally goes on to the ground and inspects the scene and sees what view train-men get of the line ahead and of the signals in case of a collision, and the state of the permanent way in case of a derailment.

He will then take the evidence of the witnesses. They appear before him in a recognised order, *e.g.*, in the case of a collision due to irregular block-working as follows:—The driver, fireman, guard (or guards) of the first train, then the driver, fireman, guard (or guards) of the second train, and then the signalmen concerned; the idea being that the men inculpated shall appear last.

Each man commences his evidence by giving his full name, occupation, length of service and how long in his then position. He then states at what hour he came on duty on the day of the accident, at what hour he would have ordinarily left duty, and at what hour he left duty the previous day.

Departmental enquiries are always held by the companies themselves into accidents, and it will often assist the Government inspector if a copy of the evidence taken at that enquiry is given him. If this is done the evidence of each man should be on a separate sheet of foolscap, and commenced as outlined above.

Board of Trade enquiries are generally held in private as the men concerned are more open and free in giving evidence. Should, however, an application be made by the Press for admission or by the legal or some other representative of a man concerned, the inspecting officer generally leaves the decision to the men most interested.

A plan of the site of the accident showing the position of the signals, the gradient and the point of collision or derailment is required. In case of a derailment, the positions in which the derailed vehicles came to rest is shown, and also any point in the permanent way where there were any marks that are referred to in the evidence.

A list of the damage done to engines, carriages, wagons and permanent way is also handed in.

Some weeks after the accident and the enquiry the officer's report is issued. It commences by relating what happened, the composition of the trains concerned, and if a passenger train what the brake power was. Particulars are then given of the number of passengers and servants killed and injured, and of the damage to stock and road, unless this be given in an appendix.

Then follows what is styled "the description," which specifies the locality, the direction of the line, the names of the signal boxes, the position of the signals, the distance they are apart, and their relation to the point of collision.

Any rules having reference to the operations under review are then quoted.

Then follows the evidence and afterwards "the conclusion," in which the events and the evidence are summarised; the leading points are surveyed, and any weak or contradictory statements are examined and weighed. Finally the opinion of the inspecting officer as to the cause of the accident is given, accompanied by recommendations as to what precautions should be taken, what alterations (if any) of working or signalling or other equipment is required to prevent a recurrence of the accident. Long hours worked, or any lack of supervision, is commented upon.

A certain number of copies of the report are sent to the company or companies concerned, also to the Press.

Subsequently the reports find their way to the public in "blue-book" form after "being presented to Parliament." These blue-

books are generally issued three times a year, the first for the three months ending March 31st, the second for the three months ending June 30th, and the third for the six months ending December 31st.

When an accident leads to criminal proceedings, as in the collision at Sutton Coldfield on April 12th, 1903, and at St. Enoch's station, Glasgow, on July 27th, 1904, the inspecting officer's report is kept back, and not made public until the criminal proceedings are concluded. In the case of the Sutton Coldfield accident the report was not published until quite six months after the accident.

In addition to the blue-books just named an annual general report is issued which, *inter alia*, summarises all the accidents of the year—the apparent cause and the inspecting officer's conclusions.

(To be Continued.)

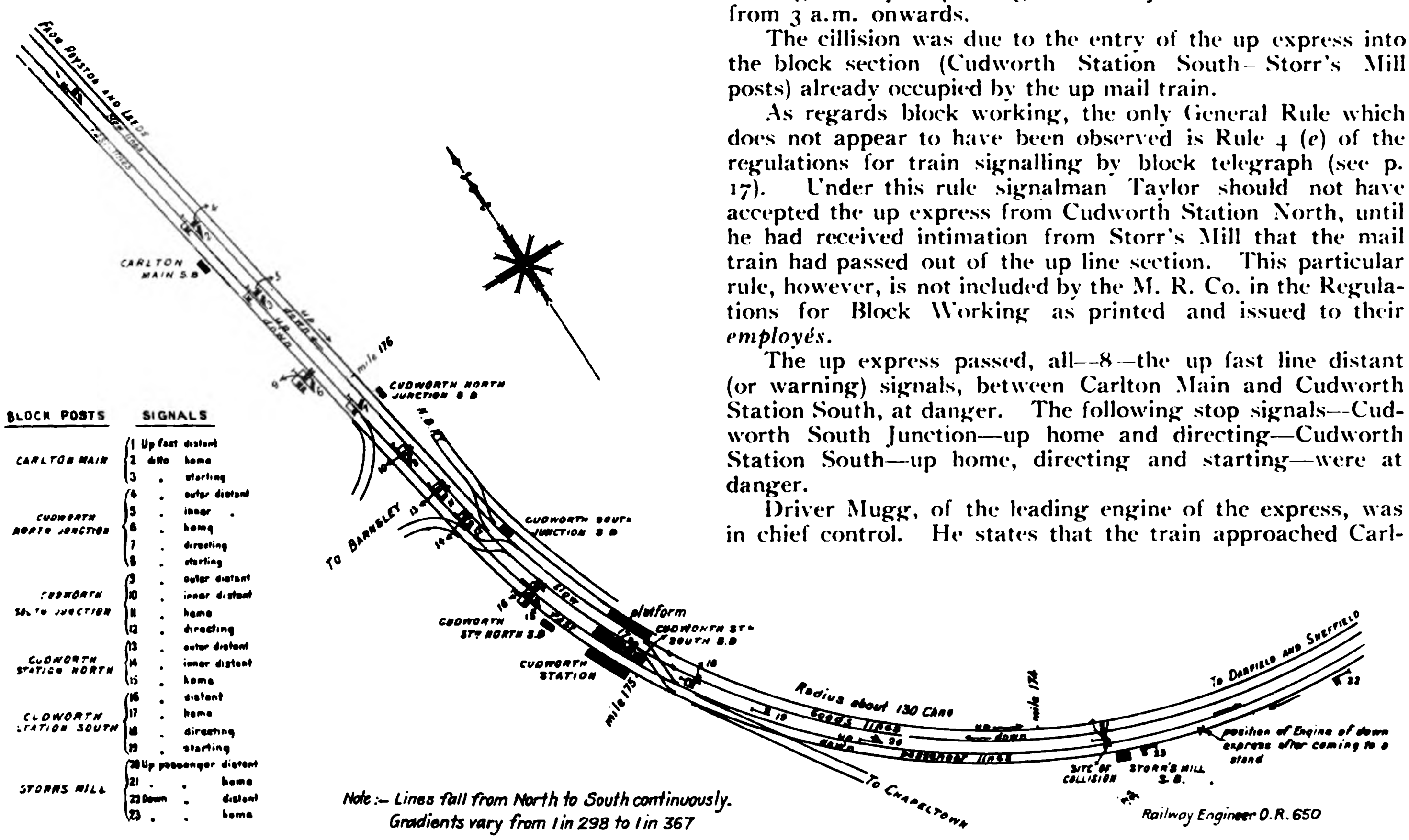
Official Reports on Recent Accidents.

Near **Cudworth Station, M.R.,** *on the 19th January. Major J. W. Pringle reports that:—*

The 2.25 a.m. up mail (Leeds to Sheffield) was overtaken and run into by the 3.5 a.m. up express (Leeds to St. Pancras); 5 passengers and 2 servants and 12 passengers and 5 servants were injured. A fish truck (of the mail) was knocked foul of the down main line and was run into by the midnight down express from St. Pancras, but little further damage resulted.

The mail train consisted of a 4-coupled engine, 6-wheeled tender, 6-wheeled brake van, two 4-wheeled fish trucks, 8-wheeled compo, 6-wheeled 3rd, two 4-wheeled fish trucks, 6-wheeled brake van, and 8-wheeled brake van.

The up express had two 4-coupled engines (the train engine had an 8-wheeled bogie tender), and nine 8-wheeled, one 12-wheeled, and two 6-wheeled vehicles.



The down express consisted of 4-coupled engine, tender, and 9 vehicles.

All the engines and tenders were fitted with steam brakes, worked in combination with the vacuum automatic brake, which was fitted to all the wheels of all the trains and which was in good order.

Of the mail train the engine and tender alone escaped derailment; three of the coaches being knocked to pieces. Both engines and the first nine vehicles of the up express were derailed. The leading engine and tender and three coaches were overturned and broken up. Fire broke out shortly afterwards amongst the derailed coaches, and all but the last three were burnt.

A sketch plan of the section of railway between Royston and Darfield is annexed.

The leading engine of the up express travelled about 300 yards after the collision before it was overturned.

On account of the short intervals between the signal-boxes from Cudworth North Junction to Cudworth Station South inclusive, the up fast line distant signals for these block posts are controlled from box to box, so that it is physically impossible for any of the signalmen to lower their distant signals unless all those south have been previously lowered. Further the signalman in Carlton Main signal-box has printed instructions not to lower his up fast distant signal unless he sees from the indicator, provided in his box for the purpose, that the corresponding signal for Cudworth North Junction has been lowered.

There is no conflict of evidence on any material point. The collision took place in a fog, which came on about 1.15 a.m., gradually acquired great density, and was at its worst from 3 a.m. onwards.

The cillision was due to the entry of the up express into the block section (Cudworth Station South—Storr's Mill posts) already occupied by the up mail train.

As regards block working, the only General Rule which does not appear to have been observed is Rule 4 (*e*) of the regulations for train signalling by block telegraph (see p. 17). Under this rule signalman Taylor should not have accepted the up express from Cudworth Station North, until he had received intimation from Storr's Mill that the mail train had passed out of the up line section. This particular rule, however, is not included by the M. R. Co. in the Regulations for Block Working as printed and issued to their *employés*.

The up express passed, all—8—the up fast line distant (or warning) signals, between Carlton Main and Cudworth Station South, at danger. The following stop signals—Cudworth South Junction—up home and directing—Cudworth Station South—up home, directing and starting—were at danger.

Driver Mugg, of the leading engine of the express, was in chief control. He states that the train approached Carlton Main post in a fog so dense that, although he kept a good look out, he was unable to see any of his proper signals between Royston Station and the scene of the collision. He stood as usual on the right-hand side, with his head outside the weather board, whilst his fireman (Pattison) was on the left. All but two of the signals concerned are on the proper left of the road, and in thick weather can be more easily seen from the left-hand side of the foot-plate. It was Mugg's practice, with a capable assistant, such as Pattison, to rely

upon his fireman to see signals which he himself was unable to see from the right of the foot-plate. He affirms that he knew perfectly well his position on the line, and that, on passing the place where the distant signal for Carlton was situated, he received a hand signal from Pattison intimating that he had seen the signal light, and that it was at safety. Coupled with the fact that no detonators were exploded, he assumed that Pattison was right. He knew that with this signal at safety the road would normally be clear through Cudworth Station, and consequently did not reduce speed by applying his brakes. He did not see the distant signal for Storr's Mill on passing it, nor did he see the mail train in front of him until after the collision. He estimates his speed at 50 miles an hour. He had no brake power applied when the collision took place. Mugg's fireman Pattison was killed by the tender falling on him.

The responsibility for viewing signals rests mainly on the driver. Neither is it in accordance with general practice, even in fine weather, for a driver to rely upon his fireman in this particular, although the latter may be a capable man and know the road. In foggy weather, the responsibility for looking out for fogmen, and for observing signals, is by Rule 144 placed upon the driver. This rule lays down that, when the fog is so dense that the fixed signals cannot be seen by the engine driver, on approaching or passing them, he must, unless he see the fog-signalman's green hand signal, assume that the fixed signal is at danger. Rules 143 and 144 moreover lay down that speed must be reduced, and that engine drivers must travel cautiously, and use every possible precaution, when signals are not visible so soon as usual.

Buggins, who drove the second engine, saw two only of the signals. One of these was the directing signal for Cudworth North Junction, and the other the distant signal for Storr's Mill. Both these signals were at safety. He attributes his not having seen the remainder of the signals, although he kept a good look out for them from the left hand side of the engine, to the dense fog, and to the steam from both the engines beating down past him. He saw no reason to interfere with the working of the train, which was in chief control of Mugg, as he assumed that the latter, who was in a better position on the leading engine, could see the signals. He was aware that no fogmen were at their posts. Both men knew the road well.

The responsibility for the collision mainly rests upon driver Mugg, and, in a very much less degree, to driver Buggins for not recognising that, in the absence of fogmen, so high a speed was not justifiable in a dense fog, and for consequently failing to take upon himself the responsibility of reducing the speed. Mugg and Buggins had been on duty for about 5 and $1\frac{1}{2}$ hours respectively.

Only the distant signals for Carlton Main and Storr's Mill of the up line signals shown on the sketch are actual fog-signalmen's posts.

Between the hours of 6 a.m. and 8 p.m. fogmen have to report themselves for duty as soon as a fog occurs. Between 8 p.m. and 6 a.m., when not aware, from their own observation, of the existence of fog, the men are called up, when required, by a man appointed for this particular duty. On the night in question the usual procedure was adopted. Signalman Gambles of Storr's Mill telephoned to Cudworth station at 1.15 a.m. that fogmen were required. Station-foreman Jerram accordingly sent porter Atyeo to instruct call-man Hills to order out all the fogmen. The latter was found to be ill, and Atyeo had to return to the station for further instructions. He was then told to call ganger Moore and did so at 1.45 a.m. Moore appears to have left his house at 2 a.m. and to have instructed Kettlewell at 2.20 a.m. to call three of the men required, as he himself did not know their addresses. An hour therefore elapsed before the arrangements for calling up the men can be considered to have been properly put into action. Even then further time was lost owing to Kettlewell not knowing the number of the house in which Blackburn resided.

Blackburn was the responsible fogman for the all-important up distant signal for Carlton Main. He was called at 2.35 a.m., and reported himself at the signal-box at 3.8 a.m. Having first to dress and then to walk a distance of $1\frac{1}{2}$ miles in a thick fog over frozen snow, he cannot be blamed for delay in reporting himself. He provided himself at the signal-box with detonators, flags, lamp, etc., and eventually arrived at his post about 3.32 a.m., just as the up express passed at full speed. Had it not been for the slippery surface of the permanent way there can be no doubt that even with the hour's delay at the commencement he would have reached his post in time to fog the signal before the express passed.

Platelayer Woolstone, who was employed to fog the Storr's Mill up distant signal, arrived at that signal-box at 3.40 a.m. after the collision had taken place. He had to call five other men before proceeding to his own work. The mail and express trains passed him, as he was walking along the railway line, from the direction of Cudworth, when there was probably an interval of about half-a-mile between the two. If he had been supplied with detonators there can be no doubt he could have checked the up express by fixing one to the rail when he heard the train approaching so close behind the mail.

Hills was at work at 5 p.m., and did not subsequently report himself sick. It was his duty, if at all possible, in view of his position as call-man for fog-men, to have immediately reported his illness to the station-master at Cudworth.

The Co.'s arrangements for fog-signalling, and for calling fog-men, cannot be described as complete and satisfactory. There may be cases when the gain of a few minutes in getting fog-men into position will avert serious and fatal results. Some railway companies have built, or own, cottages on their own land in which platelayers who act as fog-men are housed. This is the ideal arrangement, where manual fog-signalling obtains. It is easy, in such cases, to arrange for direct communication from a signal-box to cottages so situated, even when located at some little distance, by utilising the railway telegraph wires. Where such facilities do not exist, or cannot be provided, it should be possible to elaborate a system by means of which no valuable time shall be wasted in warning fog-men that their services are required. The men employed to fog distant signals are first required on the ground, and for safety of traffic are by far the most important.

Dealing with this concrete case, Blackburn and Woolstone are the two men whose services, in case of fog at night, are most urgently needed. If these men cannot be located in railway quarters the Co. should ensure, by renting if necessary, that they occupy houses in close proximity to the scene of their duties. Again, where no other means can be provided for calling fog-men, two men at least should be appointed to call them out, so that, in case of illness, which should be immediately reported, a second man may always be available, who is well acquainted with the position of the various houses occupied by the fog-men. It should, further, be no part of the duty of a regular fog-man, such as Woolstone, to call other men, before proceeding direct to his own post. The provision of detonators has also to be considered. Fog-men generally obtain their supply either from a signal-box or a station, and are in the first case unable to comply with the instructions contained in the last paragraph of Rule 80 (*a*). The duplex detonator now in common use is not a safe thing to leave about, and is more costly than the old type, but it should be possible, with due regard to safety, to arrange to store detonators, at all events for men who fog distant signals, at some point on the railway which the men have to pass on their way to report themselves for duty. This collision might, it appears, have been minimised, if not altogether averted, if Woolstone had been able to supply himself with detonators before reaching Storr's Mill signal-box.

With manual fog-signalling, therefore, at all events at busy block posts, this collision points to the necessity of providing signalmen with some means whereby they can protect the line, in the immediate vicinity of their post, in case of sudden fog, or delay in the arrival of fog-men. Some railway companies have provided their signalmen with a simple arrangement of four cross arms, each carrying a detonator,

which can be worked from the signal-box. There are other more elaborate machines, which can be operated from some little distance. Machines of this type have been supplied at many fog-men's posts, and they can easily be adapted for use from a signal-box.

Turning now to other methods of fog-signalling which have been invented to do away with the necessity for employing fog-men at signals, these methods possess the great advantage of being available for use at all times. But two points have to be established before the adoption of any system of purely automatic, or purely mechanical, fog-signalling can be advocated in preference to the manual system now chiefly in use on English railways. Firstly, it must provide both a positive as well as a negative indication—in other words, it must duplicate the safety as well as the danger position of signals. Secondly, it must be absolutely reliable under all conditions, otherwise it will be worse than no system at all.

Some of these inventions show promise of meeting these requirements, but have not been submitted to long enough practical trial to prove their reliability. Others require further elaboration to provide the dual indication. It is not clear that the possibility of replacing the manual system of fog-signalling by one or other of the more promising of these inventions has received sufficient consideration at the hands of railway companies generally.

In the meantime this case proves that it is necessary to supplement and improve the existing manual system in the following particulars :—

(*a*) Signalmen, at all events at important centres of traffic, should be provided with some mechanical device whereby they can comply with Rule 85, so far as concerns the position of stop signals in proximity to their box.

(*b*) Men selected to fog the more important signals should be required to live as near as possible to the scene of their duties, if they cannot be provided with quarters within railway limits.

(*c*) Where possible, electric communication should be arranged for between the signal-box or station and fog-signalmen's quarters.

(*d*) The arrangements for calling out fogmen by night, where this system has to be adopted, call for revision and elaboration, so that there shall be no possible delay.

(*e*) The supply of detonators to fogmen for the more important signals calls for consideration, so that it may be possible for them to comply with Rule 80 (a).

The Company omit Clause (e), of Rule No. 4 of the General Regulations for train signalling by block telegraph, because they consider obstruction to traffic constituting a most serious difficulty would result on many parts of the system. Whilst it is quite clear that in this particular instance the observance of this clause would not have prevented this collision, in times of fog the observance of the rule in question does constitute an additional safeguard for the working of traffic. Where, therefore, it is not found possible to work the traffic in accordance with this clause of the General Regulations, it is the more necessary that the arrangements for fog-signalling shall be thoroughly complete and reliable.

It was not possible to find out how the carriages of the up express caught fire after the collision. It appears to have originated in either the fifth or the sixth vehicle behind the engines. I am informed that both these coaches were lighted by electricity, and that the only gas reservoir was a small one on the sleeping car, which is utilised for heating water for the use of passengers. The fire did not break out immediately, but first appeared five minutes or more after the coaches had come to rest. Whether it was due to fire thrown out of the engine fire-boxes, or to fusing of electric circuits, or to gas, there is no evidence to prove.

*

At **Eastbourne Station, L.B. & S.C.R.,** *on the 15th January. Lt.-Col. P. G. von Donop, R.E., reports that*:—

The 8.5 p.m. up passenger train from Hastings, consisting of an engine, tender and 12 vehicles, ran into the buffer stops at Eastbourne Station.

Six passengers and two guards were slightly injured. The two leading vehicles of the rain were considerably damaged.

The engine and train were fitted with the Westinghouse automatic brake, working on to the coupled wheels, tender wheels, and 60 out of 78 of the carriage wheels. The brakes were in good order nd acted properly.

The night appears to have been a very cold one, but clear, there being no fog; there was a red light on the buffer stops at the time of the collision.

This accident was entirely due to the mistake made by driver Barber in not stopping his train at the proper spot.

All witnesses agree that Barber was in a dazed condition after the collision, but there is very strong evidence to the effect that he was at the time suffering from the effects of drink. Policeman Poate, who was on duty at the station and who spoke to Barber immediately after the collision, is distinctly of opinion that Barber was the worse for drink, and that he was not in a fit state to take charge of a locomotive. Mr. Wilkes, locomotive foreman at Eastbourne, saw Barber five minutes after the collision, and is of opinion that his dazed condition was due to drink. Dr. Habgood, of Eastbourne, who was called to the station after the accident in order to attend to the injured passengers, states that he examined Barber, spoke to him, and made him walk across the station hall; he at once formed the opinion that Barber's condition was due to drink. Dr. Habgood admits that at that time he did not know that Barber had previously met with an accident; this knowledge caused him to subsequently modify his opinion, and the conclusion he then formed was that Barber's dazed condition was partly due to his accident and partly to drink, but he emphatically states his opinion that his condition was undoubtedly partly due to the latter cause.

Driver Barber, on the other hand, attributed his dazed condition to the state of his health due to the effects of the accident which he had previously met with, and stated that he had only had four ½-pints of beer between 1.30 p.m. and the time of the accident.

Whether the general state of Barber's health can be held partially or at all responsible for his mistake on the 13th January may, perhaps, be open to doubt, but the evidence of policeman Poate, Mr. Wilkes and Dr. Habgood is conclusive that Barber was at the time suffering from the effects of drink. It is quite possible, however, as stated by both Dr. Habgood and Dr. Flide, that his Battersea accident may have rendered him more susceptible to the effects of drink than he had previously been, and that his condition on this occasion may have been brought about by the intense cold of the night acting on him after he had taken a comparatively small amount of drink, which under normal conditions would not have had any deleterious effects.

The hours of duty for which driver Barber and his fireman were detailed on the day of the collision cannot be regarded as entirely satisfactory.

These men came on duty at their headquarters in London at 8.25 a.m., and they booked off duty at St. Leonards at 1.30 p.m.; they then came on duty again at 5.30 p.m., and they would finally have booked off in London at about 1 a.m. They would thus have been away from their headquarters for 16½ hours, during which time they would have been at work on their engine for 12½ hours, and for four hours they would have been off duty at St. Leonards. This tour of duty is, it should be stated, only a Sunday one, and it would not fall to any one pair of men oftener than once in four weeks; the Co. further state that arrangements are made that men working it have 14 hours off duty both before and after it. The Co.'s

difficulties in working the morning and evening trains on a Sunday between London and Hastings without incurring these long hours are fully recognised, but the Company should consider carefully whether any steps cannot be taken to obviate the necessity for them.

*

At **Easter Road Station, N.B.R.,** *on the 5th March. Major J. W. Pringle reports that*:—

A light 6-coupled engine and tender travelling eastward through the station on the up main line collided directly with the engine of the 8.20 p.m. goods train ex Aberdeen, as the latter was entering the station from the east on the down branch line.

Both the drivers and firemen were injured.

The light engine was fitted with the steam brake on the engine wheels and the hand brake on the tender wheels. It was moving tender first.

The goods train consisted of 31 loaded four-wheeled waggons, and was drawn by a similar type of engine and tender, running chimney in front. The engine was equipped with the Westinghouse brake working blocks on all engine and tender wheels.

This collision was primarily caused by a signal remaining at "clear" after the operating lever had been replaced to "danger," and that this was caused by the twisting of a pulley bracket.

No blame attaches to driver Brand of the Aberdeen goods train. As regards driver Tait, of the light engine, it is difficult to understand why, if his speed when he reached the up platform starting signals was (as he states) as low as five miles an hour, he was unable, on a steep rising gradient, 1 in 136, to bring his engine to a stand soon enough to avoid an actual collision.

Signalman Buchanan is actually responsible for the collision on two counts. Firstly, it was his duty to assure himself that No. 24 signal obeyed the movement of his lever, and he neglected to make use of the indicator attached to the lever frame for this very purpose. Secondly, he broke the rules for block working by setting the points and lowering the signals for the light engine to cross the path of the goods train before the latter, for which he had given "clear," had come to a standstill at the home signal. He had been on duty 7½ hours.

It is not clear what twisted the pulley bracket. It had, however, the appearance of having been more than once struck by some moving object. The bracket is carried on an iron driven into the platform wall under the coping, which has an overhang at the spot of about five inches only. The driving iron and pulleys project about four inches beyond the face of the platform wall, and the minimum clearance between them and the nearest rail is about 24½ to 25ins. Elsewhere along the platform wall a clearance of about 27½ins. exists, and it is evident that the curve of the rails and platform wall do not coincide.

There is a clearance of about 2½ins. between the maximum running dimension (a leading engine step) of the Company's stock, and the pulley in question, so that it does not appear as if the blow which twisted the bracket could have been given by any fixed part of a vehicle moving on the rails. It may possibly have been given by some swinging object, such as the chain of a waggon brake pin. In any case, it is evident that at the spot in question further clearance is required, and the Company should take such action as is necessary to provide, if possible, for a clearance of 27ins. between the rail and the brackets.

*

Near **Stapleton Road, G.W.R.,** *on the 23rd December. Lt.-Col. H. A. Yorke, R.E., reports that*:—

The 3.45 p.m. passenger train (Crewe to Bristol) ran into the rear of the 11 a.m. goods train from Pontypool Road. One passenger complained of injury, and a small amount of damage was done to the rolling stock.

The passenger train consisted of a 4-coupled engine and 8 coaches, fitted throughout with the automatic vacuum brake, which was in good order. The goods train consisted of a 6-coupled engine, tender, and 39 wagons and a brake van.

The collision parted the goods train; the engine and 33 wagons went forward to Lawrence Hill, the driver being at first unaware that a collision had occurred; the 34th wagon stopped opposite the signal-box at Stapleton Road; while the other six vehicles remained at the scene of the collision, having been driven forward about two wagon lengths. No couplings or draw hooks were broken.

This collision is to be attributed to a blunder made by signalman James Miller, of Stapleton Road, who allowed two trains to be in the section between Ashley Hill and Stapleton Road at the same time, thereby breaking the principle rule of block working. The mistake seems to have arisen in the first instance in dealing with a light engine which had been assisting a down train up the incline (1 in 75) into Filton Station and afterwards had to return to Stapleton Road. This light engine is booked as having left Filton at 9.21 p.m., and after having been accepted by Stapleton Road appears to have passed Ashley Hill at 9.22. The signalman at Stapleton Road seems to have forgotten this engine, and not to have lowered his up home signal for it. The driver therefore pulled up the engine at this signal, and blew his whistle, after which the signal was lowered for him to draw down to the junction signals, where the engine remained for about 12 minutes. While it was standing there a goods train from Pontypool Road for Exeter arrived at Ashley Hill, and was accepted by Stapleton Road at 9.38, the signalman at the latter place having apparently forgotten that the light engine was standing at the junction signals. When he lowered the junction signal for the goods train, the driver of the light engine, thinking that the signal had been lowered for him, went forward into Stapleton Road Station. When he got there, the signalman expressed surprise at seeing a light engine arrive instead of, as he expected, a goods train. He then placed his up signals at danger behind the light engine, and having apparently confused the light engine with the goods train, he seems to have been unaware that there was a goods train approaching from Ashley Hill. Subsequent to this, a passenger train was offered by the signalman at Ashley Hill to the man at Stapleton Road, and was accepted by the latter at 9.55. The goods train was at this time standing at the up home signal of Stapleton Road Station, and when the signalman lowered this signal for the passenger train, the driver of the goods train, thinking the signal was lowered for him, drew forward towards Stapleton Road Station. He had barely got his train into motion when it was overtaken by the passenger train, with the result that the engine of the latter collided with the brake van of the goods train in the manner already described.

No blame attaches to the signalman at Ashley Hill or to the drivers. The driver of the passenger train passed through Ashley Hill at a moderate rate of speed, and seeing the distant signals for Stapleton Road at danger still further reduced his speed so as to be able to pull up at the home signals. After passing Ashley Hill his fireman saw the tail lights of the van of the goods train, and called out to the driver to stop. The latter at once applied his brake and reversed his engine, but was unable to stop in sufficient time to avoid a collision. He succeeded, however, in reducing his speed to about four miles an hour, and the effects of the collision were not serious.

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Contents for August.

IT is announced that **Mr. Evelyn Cecil, M.P.**, has been appointed to be a member of the Permanent Committee of the International Railway Congress in succession to Earl Cawdor. The functions of this body, which meets at Brussels, are rather more obscure than those of the "delegates" to the periodic congresses. We are not aware that it has ever done anything useful or that any attention is, at any rate in this country, paid to its deliberations or decisions, and but for the fact that it controls the contributions its existence would be of little interest to the railways of this country. These contributions, or kilometric levies, which are, quite illegally we believe, paid into the coffers of the Congress by British railway companies, tend to deplete the attenuated profits of the ordinary shareholder, who, so far as we have been able to discover, receives no adequate return for the outlay of his money.

Mr. Evelyn Cecil's appointment is one of some interest, because he was one of the "delegates" to the late Congress at Washington, who was able to endure the deadly dreariness of the proceedings which may be euphemistically described as discussing "reports," and arriving at "conclusions" which no one takes at all seriously.

Mr. Evelyn Cecil took an early opportunity of telling the world, through the medium of the hospitable columns of the *Standard*, about his American experiences. He discovered at St. Louis an "interesting and novel machine called the telautograph," being used for transmitting signalmen's messages.

Until we read Mr. Cecil's article we were at a loss to understand why directors and secretaries were sent as delegates to the Congress. He evidently took pains to see for himself what others had seen before him.

Mr. W. Temple Franks, assistant librarian of the House of Commons, has been appointed secretary of the Railway Companies' Association, in succession to Mr. W. Guy Granet, who has been appointed assistant general manager of the Midland R.

The Rt. Hon. Lord Wenlock has been elected a director, and **Mr. Henry Tenant**, director and formerly general manager of the company, has been elected a deputy chairman of the North Eastern R.

Mr. F. W. Fison, M.P., and **Mr. T. I. Birkin**, directors of the Great Northern R.; **Mr. J. Clifton Robinson**, director of the Metropolitan District R. and engineer of the London United Tramways; and **Dr. A. B. W. Kennedy**, consulting electrical engineer to the Great Western R., all had the honour of knighthood conferred upon them in commemoration of His Majesty's birthday.

Viscount Churchill, G.C.V.O., and **Sir Henry B. Robertson**, of Palé, Corwen, have been elected directors of the Great Western R.

Mr. L. C. Probyn has been elected deputy chairman of the Great Northern R.

Mr. E. Hancock, London and North Western R., Crewe, has been appointed chief storekeeper of the Ceylon Government R.

Mr. Hy. Bell has been elected chairman of the Central Uruguay R., and also of the Northern, the Eastern, and the Western Extensions, in succession to **Mr. Hy. Gibson Anderson**, who has retired from the boards of all the companies.

*

Indian Railways; Useless Ton-Mile Statistics.

THE opening sentences of the report (issued by the newly-appointed Railway Board) upon the working of railways in India during last year are refreshing, but neither complimentary nor comforting to the advocates of ton-mile and passenger unit statistics.

"The Railway Board, in issuing the report for 1904, have "considerably reduced it in size by omitting statistics (Appendices "4, 6, 12 to 16, 19 to 21, 36 and 37) that appeared of no prac- "tical use."

It would be interesting to know the total amount of money that has been spent in past years in the collection, compilation and production of these "of-no-practical-use" statistics.

*

Electrification of the Metropolitan and Met. District Railways.

THE electric working of these railways was commenced on the 1st ultimo, but the discovery of the fact that the slippers and the conducting rails of the two companies did not work together properly was carefully preserved until the public service was commenced, with the result that the Circle trains were at once withdrawn and the steam trains reappeared. A heavy thunderstorm, which flooded the District line at Earl's Court and caused some trouble, formed a convenient "scape-goat," and satisfied the public. The electric trains re-appeared the next day, and worked between Ealing and Whitechapel on the District line and between South Kensington and Aldgate on the Metropolitan; but at the time of writing the Circle was still worked by steam. The slippers spark very prettily in the tunnels, but no doubt this will cease soon.

*

Accidents on British Railways in 1904.

THE General Report to the Board of Trade upon Railway

Accidents in the United Kingdom in 1904 shows that the chance of a railway passenger being killed in a train accident was less than 1 in 200,000,000. The number of collisions and derailments was one for 1,829,327 train miles.

The personal casualties show a general reduction; 6 passengers and 7 servants were killed and 531 passengers and 114 servants were injured by accidents to trains, permanent way, &c.; by accidents from other causes, 109 passengers and 409 servants were killed, and 2,135 passengers and 3,807 servants were injured. The total personal casualties, including suicides, trespassers, &c., were 1,073 killed and 6,889 injured.

Without making any comparisons, it may be interesting to state that, according to the accident bulletins issued by the Interstate Commerce Commission, there occurred in the latter half of last year 3,199 collisions and 2,511 derailments on the United States railways, and which caused damage to rolling stock and permanent way assessed at 4,845,154 dols. During the same period the total personal casualties were 1,983 killed and 27,234 injured, of which 281 passengers and 372 servants were killed and 3,584 passengers and 3,461 servants were injured by accidents to trains.

*

L. and North-Western Railway Picture Postcards.

We have on previous occasions drawn attention to the large and varied assortment of picture postcards which have been issued by the L. and North-Western R. Co. with the object of making the public more familiar with the beauties of the country served by their system and the magnificent rolling stocks, steamboats, permanent way and signalling arrangements by which the service is worked. Altogether 33 sets of six each are on sale, and since the carbon-type series were issued last August more than 2½ millions of the cards have been sold. Five new sets have just been issued and should be secured by all collectors, as they consist of views (reproduced in colours) of beautiful places in Ireland, Scotland, North Wales and the English Lakes and the North-Western steamers. Another new postcard which is sure to be popular is an excellent picture of Mr. Whale's latest type of engine, "Experiment," for working the Scotch express trains over the Shap.

The company have also issued a new "folder" time-table with strikingly coloured covers, and showing inside the times and particulars of all their express and through services in a most distinct and novel manner.

*

Incandescent Gas Lighting for Railway Carriages.

On the 6th ultimo, at the invitation of Pintsch's Patent Lighting Co., Ltd., we travelled to Brighton and back for the purpose of inspecting a Pullman car, which, by the permission of Mr. W. Forbes, general manager of the London, Brighton and South Coast R., has been fitted with the latest development of incandescent mantles in combination with compressed oil gas. The lighting of the car was most brilliant and satisfactory in every way.

The incandescent burner as fitted to the Pullman car lamps is constructed to take the place of the old burner and reflector, being, in fact, an adaptor for converting the existing lamps. The gas fittings require no alteration, with the exception of an adjustable attachment to the regulator.

The mantles used give an illuminating intensity of 80 candles at a distance of 6ft. from the centre of the mantle, with a consumption of only 1·3 cubic ft. of gas per hour. This will be the more appreciated when it is understood that the original flat flame burners, of which four were used in each lamp, consumed 3·5 cubic ft. of gas per hour and gave a light of only 28 candles. These improved burners also have the great advantage of taking mantles giving from 25 to 80 candle power as desired, by a simple adjustment of the gas and air supply.

The mantles, which are specially made for railway carriage lighting of a much tougher material than formerly, stand the strain well for about two months, and are commonly run for as long as four months without being destroyed. They also have the advantage of slightly increasing in illuminating intensity after having been in use a short time.

*

An American Opinion of English Railways.

Some time back a number of American railway men subscribed a considerable purse which was presented to Mr. G. M. Bashford, editor of the *American Engineer and Railroad Journal*, with the request that he would make an extended tour among the railway systems on this side of the Atlantic and tell his readers all about the good things he might see. The result has been a number of most interesting letters from Mr. Bashford's pen have been published, and after inspecting the British, French and German railways he drew some comparisons. This is what he said about our railway services.

"In England competition has had a very important effect, and "the English railways serve the convenience of the people better "than those of any other country which I visited. There are "trains for all kinds of people; workmen travel to and from their "homes to the large cities for almost nothing, and the best "accommodations are available for those who can pay for them. "English train service is exceedingly good, and the efficiency of "the English railway 'servant' is a source of wonder. The "amount of work done by a few poorly paid employees is remark-"able. The competition has led to the perfection of locomotive "design for conditions which are, however, rapidly changing as the "weights of trains increase."

*

Microscopic Examination of Metals.

Messrs. R. and J. Beck, Ltd., 68, Cornhill, London, have just issued a catalogue of all the appliances and instruments for the preparation and examination of metals by means of the microscope. This catalogue will be sent free on application, and will doubtless be useful to metallurgists who have difficulty in obtaining supplies for this branch of their work.

*

Excursions to Liege.

In connection with the Exhibition at Liége, at which there is the finest collection of French and Belgian rolling stock that has been on view since the last Paris Exhibition, the South-Eastern and Chatham R. are issuing some very cheap 1st, 2nd, and 3rd class excursion, tickets available for 7 days, *via* either Calais or Ostend.

Books, Papers and Pamphlets.

Modern Engines and Power Generators. A practical work on prime movers and the transmission of power—steam, electric, water and hot air. By Rankin Kennedy, C.E. Vol. V. London: The Caxton Publishing Co., 84-86, Chancery Lane, W.C.

Unlike several other encyclopœdic technical works that might be mentioned this one is maintaining its excellent standard, and we find Vol. V. equally as deserving of the high opinion we have previously expressed of the earlier volumes.

Volume V. deals with marine engines and turbines for ships and boats, and with locomotives—steam, petrol and electric.

The examples described and illustrated are good and typical. The chapter on locomotives might, perhaps, with advantage, have been more complete, but this, from our point of view, we do not consider as a great fault because it is in directions other than locomotive engineering that this great work will be of value to the railway mechanical engineer as a most useful reference book.

Books Received.

Railways and other Rates. With an appendix on the British canal problem. By EDWIN A. PRATT. London: John Murray, Albemarle Street. 1905. [361 pp. 8ins. × 5½ins., price 5s. net.]

The Commercial Management of Engineering Works. By FRANCIS G. BURTON, A.S.A.A. 2nd Edition revised and greatly enlarged. The Scientific Publishing Co., Manchester. [432 pp. 8½ins. × 5½ins., price 12s. 6d. net.]

Practical Alternating Currents and Alternating Current Testing. By CHAS. F. SMITH, Assoc. M. Inst. C.E., A.M.I. E.E.; Wh. Sc. Manchester: The Scientific Publishing Co. [437 pp., 8½ins. x 5½ins., price 6s. net.]

Effect of Temperature on Insulating Material. Report issued by the Engineering Standards Committee, Leslie S. Robertson, M. Inst. C.E., secretary. London: Crosby, Lockwood and Son, 7, Stationers' Hall Court, E.C. December, 1904. [Price 5s. net.]

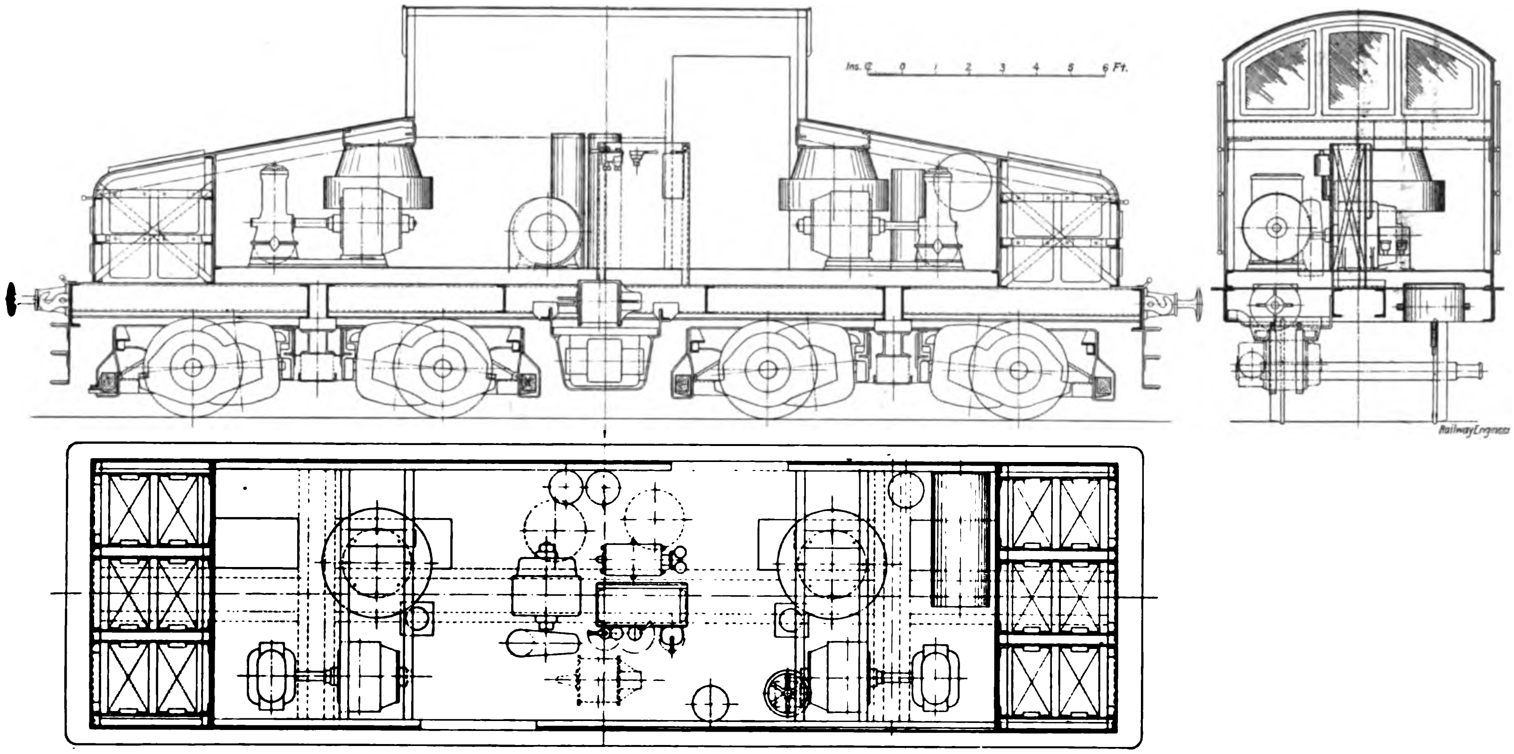
American Trade Index, 1905. National Association of Manufacturers, 170, Broadway, New York City, U.S.A.

Electric Locomotives: Metropolitan Railway.

IN our last issue we published an outside view and short description of the electric locomotives which have been contructed by the British Westinghouse Co. and the Metropolitan Amalgamated Railway Carriage and Wagon Co. for the Metropolitan R., and we are now able by the courtesy of Mr. C. Jones, electrical engineer to the Met. R., to give the annexed diagram showing the general arrangement of the machinery ot these locomotives, which are capable of hauling a goods train of 250 to 300 tons weight.

They have two pairs of motors rated at 250 h.p. each and are fitted with the Westinghouse pneumatic control and also with both the Westinghouse and the Vacuum Brake Co.'s brakes so that they can be coupled to trains fitted with either brake.

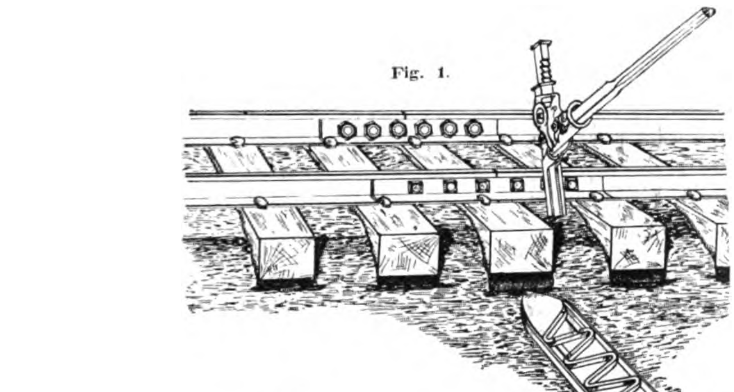
The weight of these electric locomotives is 50 tons each.



50-Ton Electric Locomotive; Metropolitan Railway.

Walters' Ballast Packing Scoop.

A NEW tool for placing ballast under sleepers has been introduced by Walters and Okell, Fort Madison, Ia., and the method for using it is plainly illustrated. The tool consists of a pan or trough, into which fits a looped iron called the cleaner, which holds the ballast in place while the pan is being withdrawn, after which the cleaner is lifted out, leaving the ballast under the sleeper. Extensive tracks ballasted with common dirt, cinders or sand, are, says the *Railway Review* (Chicago), surfaced by raising them above the intended level and throwing loose ballast into the openings under the ends of the sleepers. The material is then compacted by the weight of the trains. The reason for such practice is that soft ballast of the kinds named cannot be compacted with a tamping bar or shovel, and the use of such tools breaks up the old bed, making the support for the sleeper insecure. For this reason permanent way men prefer not to interfere with the old bed of the sleeper, but to get new material on top of it. Unless the track be raised pretty high, however, it is difficult to throw ballast far enough under the sleeper to afford desirable support. The tool here described will put the ballast as far



as the middle of the sleeper. The tool is said to be in use on upwards of 20 railways, and stone and gravel ballast of small size, as well as the kinds above named, are readily handled by it.

The Use of the Indicator on Locomotives.

A GREAT deal is written nowadays upon the subject of locomotive performance, but very little information of any value from a technical point of view is available to show what the cost per unit of power amounts to, in operating locomotives under modern conditions or, cost apart, what the ratio of work to fuel and steam consumption really is.

The mere statement that such and such a locomotive has covered so many miles whilst hauling a given load, at an average speed in miles per hour, contains nothing of interest from a scientific standpoint, although it serves to demonstrate that the locomotive is capable of overcoming the physical difficulties encountered in the course of performing the task allotted to it. A study of the coal sheets showing the average rate of fuel consumption per mile run, whilst engaged on this particular work, might possibly have a sobering effect upon those who pen the glowing accounts of locomotive performance to which we refer,—if access to such information were to be had,—but in any case knowledge of the facts would certainly go far towards discounting the value attributed by some to such writings, which after all are based almost entirely upon superficial considerations. At the same time it must of course be remembered that even with the best intentions in the world it is impossible for anyone to publish inaccessible data, and it is to be regretted that more opportunities are not forthcoming for the publication of reliable detailed information bearing upon the working of locomotives from the point of view of steam and coal consumption and such like considerations.

It may be considered doubtful whether a true appreciation of the value and importance of such knowledge exists even in locomotive engineering circles judging by the spasmodic use which is made of the indicator in this country for determining locomotive performance, yet it is certain that the scientific designing of such engines must largely depend upon intimate acquaintance with the principles of steam distribution and be, to no slight extent, consequent upon the evidence of the indicator diagram. We may assume that the locomotives of a company operating only 200 miles of railway will use 1,200 tons of coal per day, which, at ten shillings per ton, represents an annual expenditure of £175,000. If the application of the indicator resulted in preventing a waste of only 5% of fuel, the saving to such a company would be £8,750 per year.

In the accompanying photographic reproductions we illustrate a new type of Indicator specially designed for use on locomotives and other high speed engines. This instrument has recently been placed upon the market by Messrs. Dobbie, McInnes, Limited, of 45, Bothwell Street, Glasgow, and is known by them as the "Cipollina McInnes-Dobbie" continuous double diagram Indicator. By its use pressure diagrams may be taken simultaneously and automatically from both ends of the engine cylinder, together with time and revolution diagrams; thus all the elements required for an absolutely correct indication of the engine are obtained during the same stroke, and as these diagrams are automatically repeated at exact intervals, any variations in the running conditions are shown by comparison, and a true average obtained. The apparatus automatically records by means of diagrams the true average pressure in the cylinder during particular revolutions, and as the speed and time are also graphically registered all error due to carelessness on the part of the operator, such as may occur when the ordinary single diagram indicator is being used, is eliminated. For this indicator it is claimed that as all the elements necessary to the calculation are registered simultaneously the true power of the engine is thus obtainable.

The apparatus consists of two indicator cylinders with pistons and parallel motions of the "McInnes-Dobbie" patent type, the pressure springs being exterior to the steam cylinder and rendering the indicator particularly accurate at high pressures. The cylinder caps, coupling nuts, and other parts are sheathed with a special vulcanite preparation to prevent burning of the fingers. Pressure springs are fitted exactly as in an ordinary indicator.

Both pencil arms point towards the same paper cylinder, this latter containing a roll of metallic paper carried from the spindle A between the rollers B, round the exterior of the cylinder and re-entered to the spindle C. One of the indicator cylinders is attached to the top of the engine cylinder and the other to the bottom. The cocks can either be placed between the indicator and the piping, or at the end of the piping against the engine cylinder.

The cord lead D, adjustable to any angle, is next attached to a suitable part of the engine. Assuming now the engine to be in motion, when the cocks are opened and the drum cord connected to the engine, the pencil arms rise and fall and the drum reciprocates at each stroke. But this indicator is not intended to take diagrams at every revolution. At every stroke of the drum, by means of internal mechanism, the spindle E is lifted upwards, imparting motion to the cam F, which propels the ratchet wheel G one tooth forward for every revolution. Attached to the wheel G there is a cam wheel H having a plain surface with projecting points on it. Both wheels turn round together, the pawl I resting on H, and when a projection comes under it the pawl I is of course raised. This pawl in turn, by means of the connecting bracket K, carries the two pencil points L against the metallic paper, and as the paper drum is reciprocating and the pencil arms rising and falling at each stroke, at this moment of contact one pencil gives a diagram from the top end of the cylinder and the other a diagram from the bottom end, both being taken simultaneously and on the same length of paper. Until this moment of contact the metallic paper has been reciprocating with the drum, but immediately the diagrams are taken the pencil points are released and the same mechanism now causes the length of paper occupied by the diagrams just taken to be drawn forward into the drum round the spindle C, leaving a fresh portion of the same paper, drawn from the spindle A, ready for the next set of diagrams. This goes on automatically until the paper is exhausted.

It is the cam H that determines the diagram intervals. The one on the illustration has two projections, causing diagrams to be taken at every 50 revolutions, but each indicator is supplied in addition with interval wheels to give diagrams at every 25 and 100 revolutions. On the indicator shown, with the engine running at 100 revolutions, double diagrams would be taken automatically at every half-minute.

In the revolution and time recording gear, the wheel G, as shown on figs. 1 and 2, is connected by means of a spindle to a second paper drum M, over which a strip of metallic paper is led from the spindle U under the guide pulley V. At each turn of the large paper cylinder the pawl N (fig. 1) receives a

kick forward, turning the wheel O round one tooth, this in turn propelling the lever with pencil point P forward. This pointer therefore records every turn of the drum, equal to every revolution of the engine, and is designed to miss at every tenth stroke, as shown on the diagram, thereby enabling the revolutions to be read in multiples of ten as well as individually.

To register the time occupied during the test electrical contact should be made to the two connections R (fig. 1), the other end of the wire being attached to a clock suitably arranged so that current can pass through at any period desired, every 30 seconds or every minute as may be necessary. The fitting of this electrical attachment is a very simple matter. If designed so that contact is made every 30 seconds, at this period the arm with pencil point S is drawn forward by the plate T, placed between the electrical coil and the pencil arm. Every forward mark therefore indicates 30 seconds of time, and it is a simple matter to compare the two sides of the paper strip, on one of which the time is displayed and on the other the revolutions, both being recorded simultaneously.

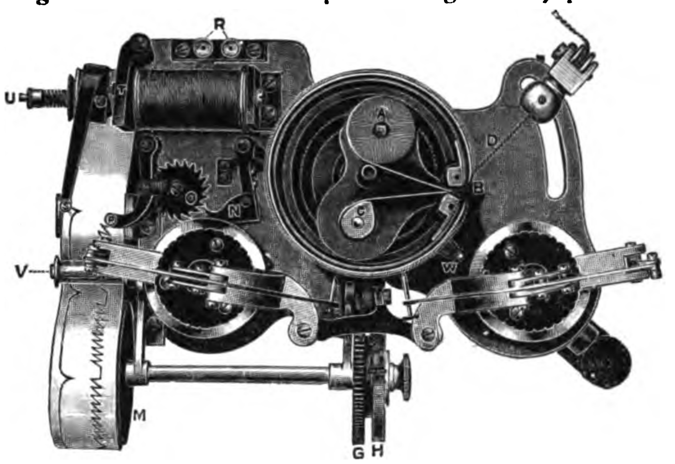


Fig. 1.

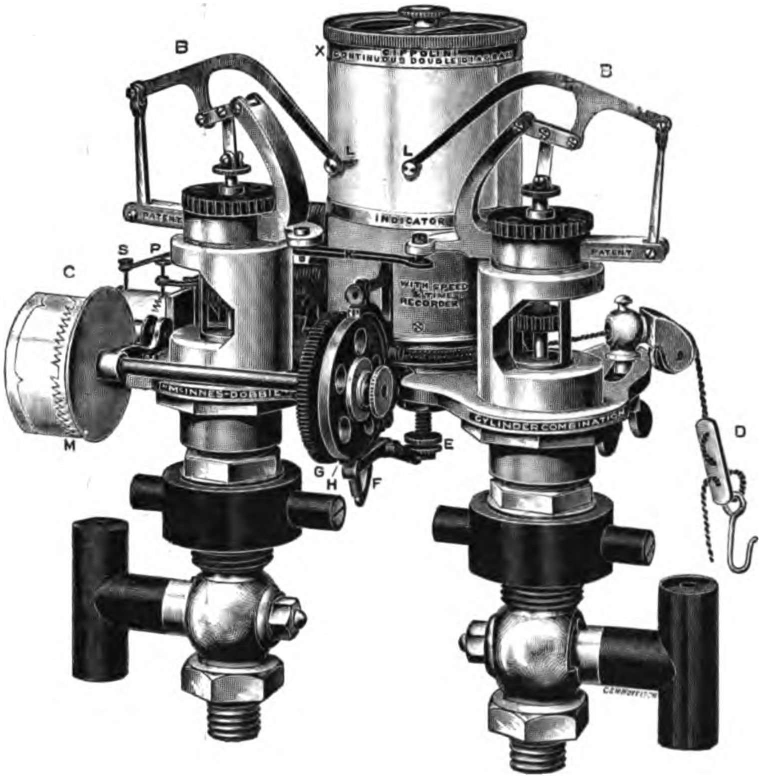


Fig. 2.

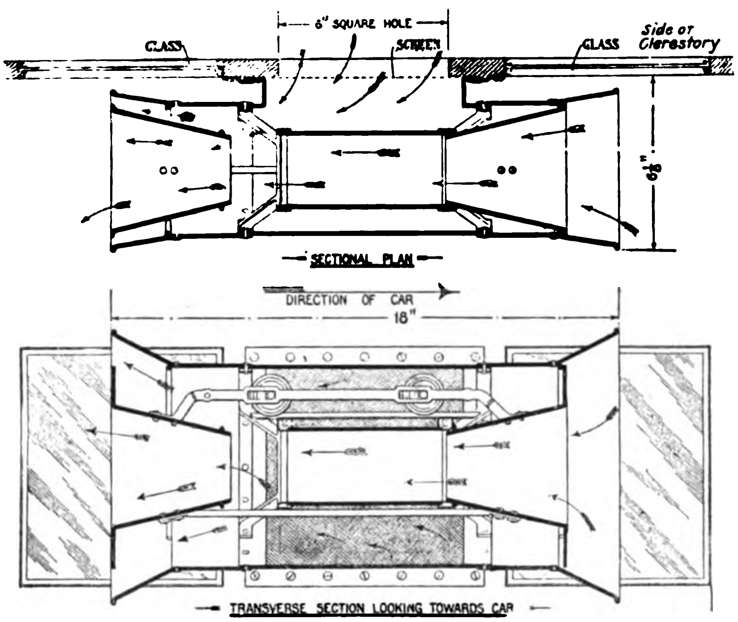
When so required the indicator can be used without this revolution and time indicator.

The roll of paper on which the power diagrams are traced can then be arranged in conjunction with the strip showing revolutions and time, thus giving a clear indication, and showing in a manner that cannot be contested two essential elements required for an accurate engine trial. Those elements are the moment at which the diagrams were taken in connection with the number of revolutions, and the number of revolutions that the engine was making at the moment when the observation was taken.

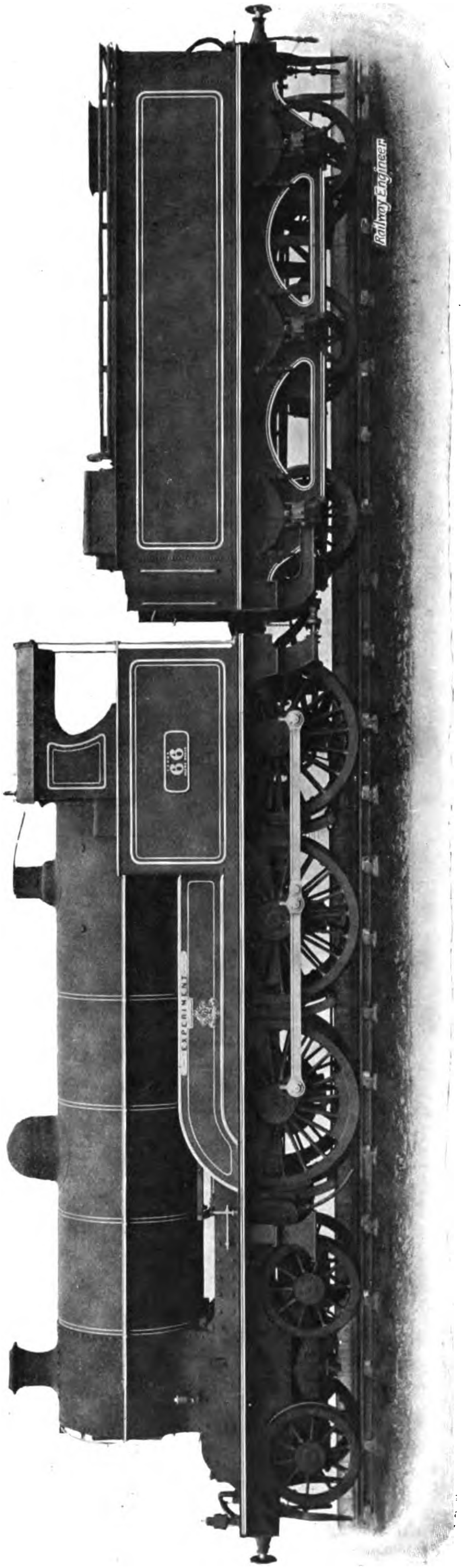
Messrs. Dobbie, McInnes, Limited, inform us that they also manufacture, among other instruments, a single type Indicator for locomotive use, in two patterns, one with external and the other with enclosed pressure springs. With this type the diagrams must of course be taken at different times for each end of the cylinder and cannot be obtained simultaneously as with the "Cipollina" Indicator.

The Improved Andrew Ventilator.

This ventilator is designed to fit on to the sides of clerestory roofs of railway carriages. It is of the exhaust type; operates on the ejector principle, and automatically reverses itself in accordance with the direction in which the train is moving. It is fixed in connection with the sash openings; the screen is removed and a frame, provided with glass, except for the 6in. square screened opening for the ventilator connection is substituted. The ventilator, says the *Railway Review* (Chicago), is storm proof against transverse storms; rain, snow, smoke and cinders striking it longitudinally are carried through the ventilator beyond the opening connecting with the car. The reversal of the ventilators when the direction of the motion of the car is changed takes place at as low a speed as four miles an hour. The cones move on friction rollers and are noiseless in their action. Tests show hat the average amount of air exhausted by each ventilator at varying speeds is 24 cu. ft. a minute, or 1,440 cu. ft. an hour, and at that rate four of these ventilators applied to a large smoking compartment (say 6ft. wide and 8ft. long) will effect a complete renewal of the air in the room every five minutes.



The Safety Car Heating and Lighting Co. are the manufacturers of this ventilator.



Six-Coupled Passenger Engines; London and North-Western Railway.

Six-Coupled Passenger Engines: London and North Western Railway.

THESE engines—4-6-0 type—were built at the Crewe Works to the designs of Mr. Geo. Whale, M.Inst. C.E., Chief Mechanical Engineer of the London and North Western R., especially for working the heavy express trains between Crewe and Carlisle, which section includes the heavy gradients over the Shap. The first engine of the class ran its trial trip from Crewe to Carlisle and back on 21st May last, with a train of empty coaches weighing (exclusive of engine and tender) 373 tons 9 cwt. 3 qrs.

Our illustration is reproduced from a photograph for which we are indebted to the courtesy of Mr. Whale.

The leading four-wheeled truck is fitted with a radial axle-box and side controlling springs.

The cylinders are between the frames, and their valves are operated by Joy's gear.

The coupled wheels are 6ft. 3ins. diameter with 3ins. tyres, and the truck wheels are 3ft. 9ins. diameter.

The working pressure is 175 lbs. per sq. inch. The heating surface is 2,041 sq. ft., of which the tubes provide 1,908 sq. ft. and the fire-box 133 sq. ft.; the grate area 25 sq. ft.

The tender has a water capacity of 3,000 gallons, and carries 6 tons of coal. It is constructed entirely of steel. Its wheels are 3ft. 9ins. diam. It is fitted with a water "pick-up," the scoop being worked from the footplate by a hand wheel and double-threaded screw.

The following are some of the leading dimensions:—

Cylinders.—19ins. diam.; stroke, 26ins.; distance apart, centre to centre, 1ft. 10ins.

Valves.—Maximum travel, 5ins.; lead, $\frac{3}{16}$ in.; lap, $1\frac{1}{16}$ in.

Boiler (Steel).—Length of barrel, 12ft. $7\frac{3}{8}$ins.; largest diameter outside, 5ft. 2ins.; least diameter outside, 4ft. $11\frac{1}{2}$ins.; thickness of plates, $\frac{5}{8}$in.; working pressure, 175lbs. per sq. inch; height of centre line above rails, 8ft. 7ins.

Firebox Casing (Steel).—Length outside casing, 8ft. 2ins.; width outside casing, 4ft. 1in.; depth below centre line of boiler, 4ft. $7\frac{1}{2}$ins.; thickness of plates, $\frac{5}{8}$in.; stays (copper), centre to centre, 4ins.

Firebox (Copper).—Length at bottom (inside), 7ft. $5\frac{1}{8}$ins.; width at bottom (inside), 3ft. $4\frac{1}{8}$ins.; thickness of plates, $\frac{9}{16}$ in.; thickness of tube plate (copper), 1in.

Tubes.—Number, 299; length between tube plates, 13ft.; diameter (outside), $1\frac{7}{8}$in.; diameter of blast pipe nozzle, 5ins.; Height of chimney from rail, 13ft. $4\frac{1}{2}$ins.

Wheels.—Diameter of truck wheels, 3ft. 9ins.; diameter of coupled wheels, 6ft. 3ins.; thickness of tyres on tread, 3ins.

Wheelbase.—Distance between centre of truck and centre of driving wheels, 10ft.; centres of truck wheels, 6ft. 3ins.; centre of driving to centre of intermediate wheels, 6ft. $9\frac{1}{2}$ins.; centre of intermediate to centre of trailing wheels, 6ft. $9\frac{1}{2}$ins.; total wheel base of engine, 26ft. $8\frac{1}{2}$ins.; tender wheel base, 13ft. 6ins.; total wheel base of engine and tender, 48ft. $4\frac{1}{4}$ins.

Frames (Steel).—Distance between, 4ft. 2ins.; thickness, 1in.

Weight of Engine in Working Order.—
On truck wheels, 19 tons 0 cwt.
On driving wheels, 18 tons 5 cwt.
On intermediate wheels, 15 tons 5 cwt.
On trailing wheels, 13 tons 5 cwt.; total, 65 tons 15cwt.

Weight of Tender in Working Order.—
On front wheels, 12 tons 0 cwt.
On middle wheels, 12 tons 5 cwt.
On trailing wheels, 12 tons 15 cwt.; total, 37 tons 0 cwt.

Total weight of engine and tender in working order 102 tons 15 cwts.

Reinforced Concrete—IV.

ROOFS.

It was not until 1902 that reinforced concrete began to be used for the coverings over subways made for railway purposes, and for cases of cut and cover work the facility with which the material could be used at once became apparent. Previously, long and heavy beams had to be lifted and laid down in situations where every available inch of space was with difficulty obtained for the work, cranes and derricks for handling the heavy beams were necessary in situations where it was extremely difficult to erect lifting apparatus of any kind. The use of reinforced concrete which could be made of small and light materials, easily handled without the use of combrous lifting tackle, at once saved trouble and expense, and the subways of the Boston, Philadelphia, Brooklyn, and New York districts were covered in with the new material.

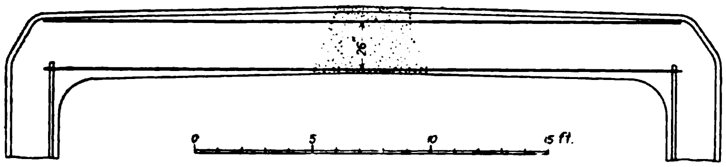


Fig. 1.

The Rapid Transit RR. of New York at Battery Park is practically a rectangular double track cross section with reinforced concrete in the floor, walls and roof, but it is only with the roof that we are at present dealing. The span of the subway is 25½ft., and there is no steel work in the walls or roof requiring painting or maintenance. There are two systems of horizontal rods in the thickness of the roof, those in the lower system being 1¼in. round rods, arranged in pairs every 5ft., and being attached at each end to the upper part of the vertical reinforcement of the side walls—between these pairs of 1⅛in. rods are laid 1¼in. rods, spaced 4in. centres, but not attached to the side walls. The upper layer of rods are 1¼in. diameter, and are spaced at 7in. centres throughout (fig. 1). The thickness of concrete between the two systems of reinforcing rods is 2ft. 2ins., to which is to be added the additional thickness of concrete above the upper layer of rods and below the lower layer. Upon this is laid the water-proofing, which is protected by another thin layer of concrete.

In part of the subway the roof slab is supported by a row of bulb angles in the centre, and in this case the lower system of reinforcing has a pair of ⅞in. round rods every 5ft. with 1in. rods between spaced every 7½ins. (fig. 2). The upper

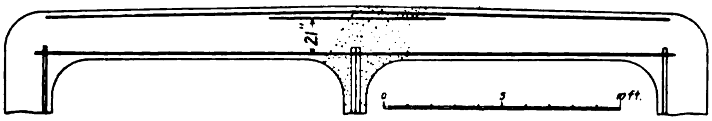


Fig. 2.

system has 1in. rods spaced 7ins., and another system of similar rods laid over the longitudinal row of columns, where some amount of tension may be anticipated due to the continuity of the roofing over the central support. All horizontal joints in the concrete of the roof were avoided, and the work was invariably and carefully racked off at the points where the work done at different times were joined together.

The station on the East Boston tunnel, opposite the Old Court House, is roofed by arches, as shown in fig. 3, of two spans, a row of steel columns, 12ft. centres, dividing the two. Between the columns is laid the horizontal skewback for the arches reinforced with nine rods, each ⅞in. diameter, close to the lower edge, as shown in the figure. When the concrete was laid for the walls it was taken forward beyond the inner faces of the walls and on each side of the row of columns to the lines x x, and the joints between the wall section and

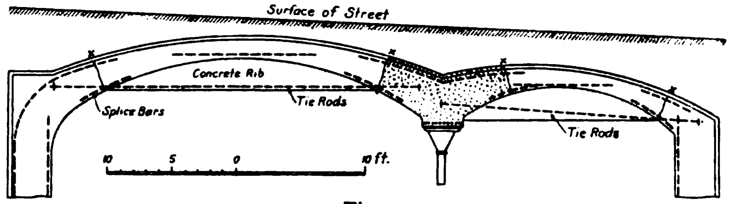


Fig. 3.

the arch proper were bonded by splice bars about 3ft. long, as indicated. The arches were reinforced by horizontal transverse rods, 12ins. centres and ⅞in. dia. The lateral thrust of both the arches is resisted by 2in. square bar tie-rods placed 2ft. 3in. centres, those in the large arch being horizontal and those in the small arch being inclined. Every fifth of these tie rods is enclosed in a rib of concrete about 15ins. thick, the other rods being left exposed.

The one-storey machine shop of the Bilgrim building at Philadelphia has a saw tooth roof (fig. 4) built of reinforced concrete, and is supported on columns 8ins. square, spaced at 14ft. 4ins. centres, between the walls. A 12in. by 8in. horizontal beam extends longitudinally and laterally at each

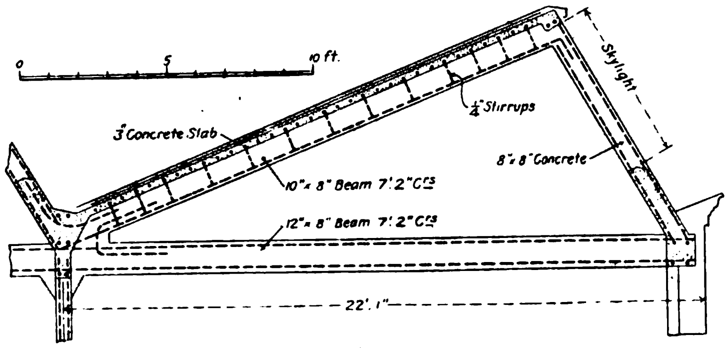


Fig. 4.

column. Midway between the columns are horizontal and inclined beams identical with those at the columns, an arrangement that gives 7ft. 2ins. span for the 3ins. slab between the centres of the inclined beams. The skylights are simple galvanised iron frames let into the concrete. The longitudinal horizontal beam has two $1\frac{1}{16}$ ins. rods at both top and bottom, whilst the transverse horizontal beams have two 1in. rods laid in the same positions. Two $1\frac{1}{16}$ in. rods are laid in each of the 10ins. by 8ins. inclined beams, and the 3in. concrete slab has ¼in. rods spaced 6ins. apart throughout its width.

The roof over the shops of the United Shoe Machinery Co., Beverly, Mass., is practically flat, as shown in fig. 5, The rows of columns supporting it between the walls are 20ft. centres, and between these are beams supporting the concrete slabs. A series of cross beams spaced 3ft. apart are made between these, and the whole structure is calculated to carry a live load of 75 lbs. per sq. ft. The roofing is water-proofed with several thicknesses of felt and tar covered with gravel. The expansion joint in this roof necessitated by the length of the buildings is an interesting detail of the construction (fig. 6). An open joint 2ins. in width is formed down the centre of the block through roof, walls and floors, and, except slid-

ing plates, there is no connection across the joint. In the roof on each side of the open joint are transverse ridges rising above the roof level, over which are bolted galvanised iron bent plates bolted down into the concrete. The main beams between the columns and wall are 2ft. 3ins. in depth, including the slab, whilst the width of the beam is 8ins. In the lower part of the beam are placed three $\frac{5}{16}$in. bars and in the upper part two ¾in. bars, and these have U bars placed vertically along the length of the beam. The smaller cross beams between the main bars are 2½ins. thick, and each have one reinforcing bar at the lower edge. The roof slabs are 2½ins. thick throughout, and are made without reinforcement.

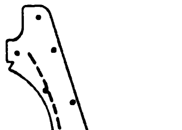
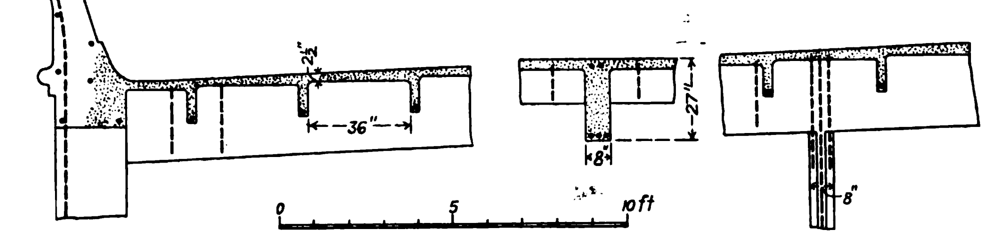
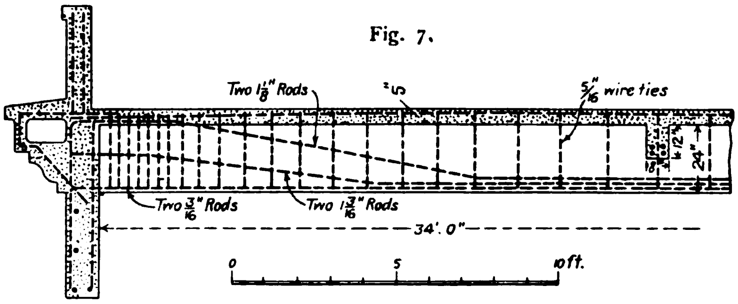



Fig. 5.

The Brooklyn Transit Co.'s sub-station at Parkville is constructed on the Bertin system, and has roof girders 24ins. by 12ins., 34ft. span, placed 14ft. centres (figs. 7 and 8), connected with a single central rib 12ins. by 8ins., covered by a 5in. slab. The whole of the reinforcement consists of round rods of steel, Atlas Portland cement for the concrete being used in the proportions for the roof of 1 : 2 : 5, with cinders screened and washed. The 5in. roof slab spans 16ft. 8ins. in the lateral direction and 13ft. longitudinally, and is reinforced by ⅜in. rods in both directions, spaced 7½in. centres, overlapping over the beams and bedded ⅜in. above the lower surface. The shape of the reinforcing rods in the beams was decided upon much in the same way as the length of the flange plates in an ordinary girder is arranged. A curve of bending moments was drawn in each case, and the maximum ordinate at the centre was divided into areas equal to the respective resisting moments of the rods, and at the end of the horizontal lines drawn in this way through the maximum ordinate the inclination of the rods was allowed to begin. At both ends of the beam the rods were made to go some distance past the support for the purpose of anchoring the beam against any possible negative bending moment at these points of bearing. Vertical ties of $\frac{5}{16}$in. wire are placed

Fig. 7.



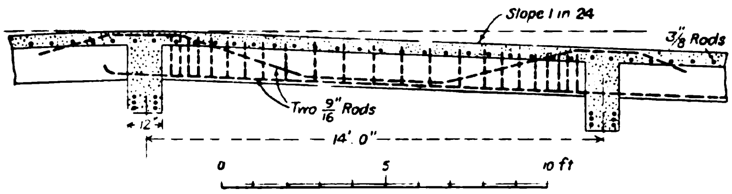


Fig. 8.

at frequent intervals along the length of the beam to resist the shearing stresses and to bind the material together. The top of the roof slab was coated with a four ply tar and gravel covering.

The roof over the coagulating basin of the filtration plant at Marietta, Ohio (figs. 9 and 10), is an interesting example of reinforced concrete roofing. The roof slabs are 4ins. thick and are about 13ft. span; they are reinforced by ⅜in. rods laid transversely, 8ins. centres, and ½in. rods 12ins. centres in the longitudinal direction. The central portion of the roof rises vertically, as shown in fig. 9, and in this are formed windows to give light to the inside of the building. The side walls of this central portion are 6ins. thick, and are

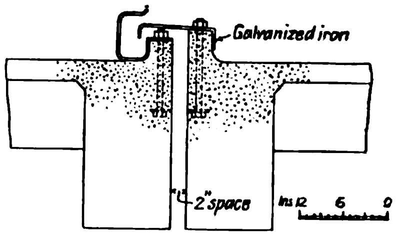


Fig. 6.

reinforced by ½in. rods placed 9ins. centres. Horizontal rods are also inserted in this wall so that it forms a girder to carry the raised roof between the main girders below. The roof slab in the centre is 3½ins. thick, and is carried on cross beams as shown in the figure. The rods used in the reinforcement are of plain steel with a tensile strength of 38 to 42 tons per square inch, and the unit stresses were calculated on the basis of 16,000 lbs. safe for tension and 10,000 lbs. safe for shear.

The Leonardt Warehouse in Los Angeles has perhaps the longest span roof girders ever yet constructed of reinforced concrete. Their span is no less than 100ft., and the girders not only carry the roof itself but are also intended to support a gallery underneath them, and even tracks for travelling cranes. The girders of this long span are 6ft. 6ins. deep in the centre, and the top surface has an inclination of 3ft. towards each bearing, over which the depth of the girder is reduced to 3ft. The width of the girder is 14ins., and in this are arranged at the bottom ten steel rods 1¼ins diameter, two of which are straight and the others bent. The top of the girder is reinforced by three similar rods. The girders are spaced at 16ft. 6ins. centres and carry ribs between them in the longitudinal direction 11ins. deep and 6ins. in width. Each of these secondary beams has four ¾in. rods inserted in the concrete, and upon the whole is laid the roofing slabs which are 4ins. thick, reinforced by ⅜in. rods, spaced 5in. centres in both directions, lateral and longitudinal. Over the slab an ordinary waterproofing composition was put down. Wire glass skylights were used for the lighting of the interior of the building, and the composition of the concrete was one part cement, 1½ parts sand, and 3 parts crushed granite for the lower part of the girders, and one, two, and four parts of the same materials for the other portions of the roof.

The framed steel roof principals of the United States Express Co. in New York are covered with reinforced concrete roof slabs only 4ins. in thickness, but of 10ft. 6ins. horizontal span and 24ft. 6ins. length of panel. Each panel is reinforced by woven steel wire fabric seven widths in each panel transversly to the walls, the fabric being made of No. 10 longitudinal wires 4ins. apart and No. 9 cross wires 6ins.

apart. The concrete used was one part cement, two parts sand, and five parts cinders. Two stiffening ribs, each containing a steel rod, are formed intermediately in each panel running parallel to the roof principals. The wire used in the fabric had an ultimate tensile strength of 112,000 lbs. per sq. inch, with an elastic limit of 90,000 lbs. per sq. in.

The dome of the U.S. Naval Academy at Annapolis is a notable instance of the use of reinforced concrete for roofing purposes. The dome itself is 70ft. in diameter, and rises to a height of 192ft. above the ground. A terra cotta lantern weighing 120 tons is carried at the summit of the dome, and this is directly supported by a reinforced concrete pyramidal frame built inside the outer dome much in the same way as at St. Paul's Cathedral in London, where the heavy lantern is carried by its own special cone of brickwork. In the case in question there is also both inner and outer domes, the load being carried down to the foundations by special columns of reinforced concrete. The construction of the domes was carried out by means of outside moulds, which were fixed first, and by inside moulds slung from them, the material being filled in between the two sets of moulds in depths of about two feet at a time.

Fig. 10.

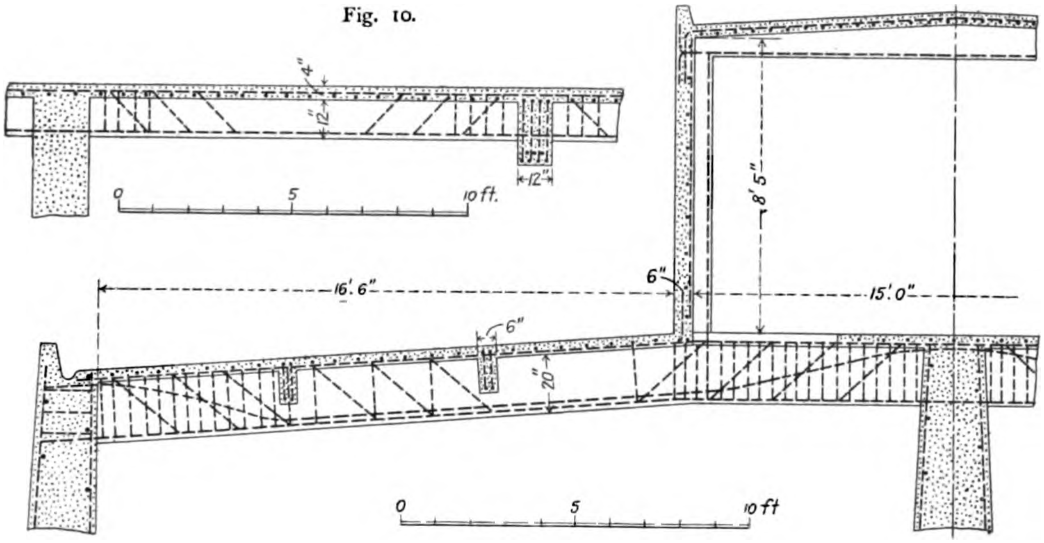


Fig. 9.

The Kahn system of hollow tiles with spaces filled in with reinforced concrete was used in the roof over the American Arithmometer Co. at Detroit, and a sketch of the saw tooth roof is given in figure 11. The supporting columns are spaced at distances of 16ft. 9ins. and 20ft. 10ins., and light iron trusses are placed upon these. For the roof covering hollow tiles 12ins. wide by 4ins. thick are laid end to end on wood forms in straight rows, a space of 4ins. being left between each of the rows. In this space a layer of 1in. of cement is laid for fire-proofing purposes, and upon this is placed the trussed Kahn bar with its diagonal prongs, fig. 12, pointing upwards towards the upper surface of the roof over the points of support. The space is then filled in by a wet mixture of cement concrete. The inside of the roofing slab is plastered with a coat of cement mortar and the outside is covered with Carey's standard magnesia roofing. It is claimed that this system of roofing is very light and comparatively inexpensive, the construction is thoroughly sound proof, and the hollow tiles provide an inner surface free from condensation, an objection noticeable in many other forms of concrete construction.

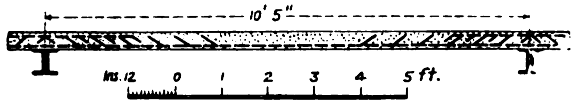


Fig. 12.

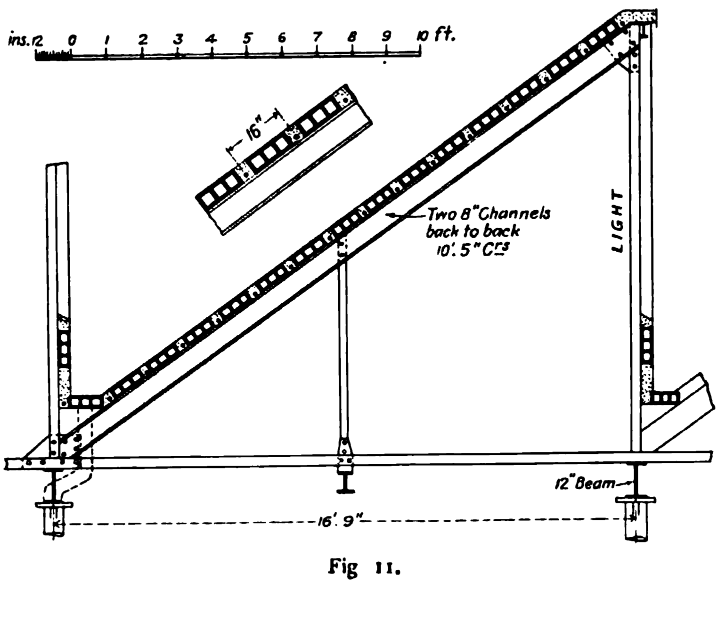


Fig 11.

In the Bulletin of the International Railway Congress, February, 1905, several interesting particulars are given of roofs and ceilings erected in reinforced concrete on the Russian railways. The ceilings over the locomotive sheds at Novotchercask are formed of arches of 10ft. 6in. span, 1ft. 0½in. rise, with a thickness of 3ins. at the crown and 4¼ins. at the springing, the reinforcement consists of wires $\frac{15}{64}$ins. and $\frac{4}{16}$ins. thick. It will be seen from these dimensions that reinforced concrete can be formed with a much longer span than if ordinary brick jack arches had been employed, and the cost without the supporting beams is given as 8¼d. per sq. ft., but with the beams 1s. 2d. per sq. ft.

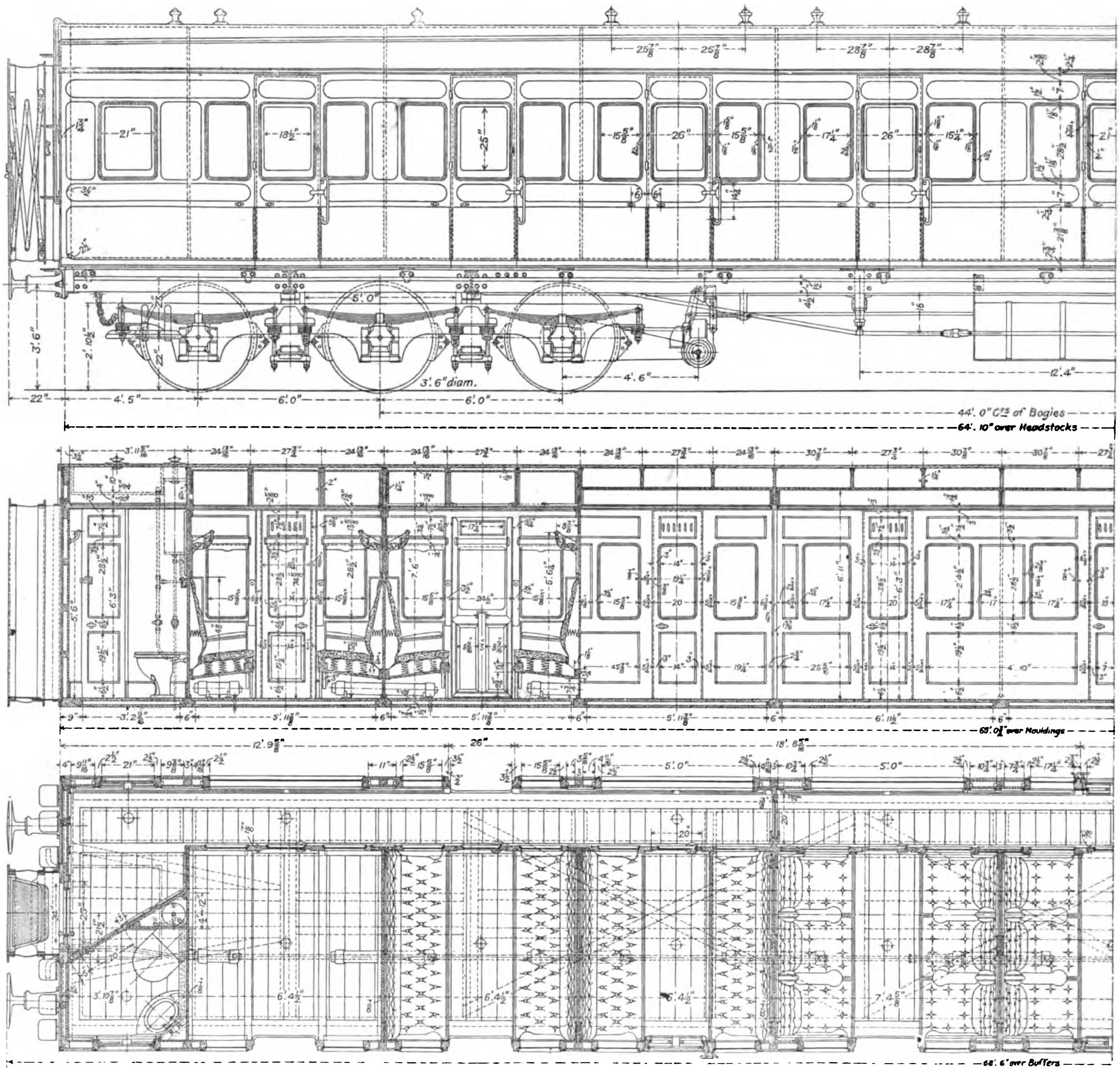
The ceilings of the locomotive shed at Kursk are formed with arches 7ft. span, 8⅜ins. rise, the thickness being 1½ins. at the crown and 2½ins. at the springing. The arch is coated with ordinary plastering, and the cost, not including beams, was 1s. 1½d. per sq. ft. Vaults for kerosine are constructed on the Moscow-Jaroslav-Archangel Railway with arches 16ft. 1 $\frac{5}{16}$ins. span, and with a thickness of 2½ins. at the crown and 4 $\frac{3}{16}$ins. at the springing. Over the arch is a layer of earth over 1ft. in thickness. Other arches are of 10ft. 10 $\frac{5}{16}$ ins. span, 5ft. 3ins. rise, thickness of crown 2½ins., at springing 4 $\frac{3}{16}$ins., the armouring consisting of iron wire $\frac{3}{16}$in. thick, spaced at 4ins. distances parallel to the axis of the vault. At right angles to this is iron wire $\frac{5}{16}$ ins. thick spaced at 3¼ins. apart. The concrete used was 1 Portland cement and 3 of coarse river sand, a finishing coat of cement 1 to 1 being also applied. Such vaults are covered with earth and turfed two

or three weeks after the arches are made, the centreing being removed a week later.

The locomotive shed at Sary-Zazy on the Murga line has a vault of 39ft. 11ins. span, formed as a semi-circle, the thickness at the crown being 4½ins. and at springing 6½ins. The reinforcement consists of rods ⅜in. and ⅝in. thick, bound together at the intersections by $\frac{5}{32}$in. telegraph wire. The vault was completed in 60 hours, and 3 hours afterwards the extrados was covered with wet matting, which was kept wet for a fortnight by water pumped upon it. Two weeks later the centreing was removed. The concrete used was 1 part Portland cement and 3 parts sand and coarse gravel, and the vault was covered with cement mortar of 1 to 3 consistency, the cost being 2s. 1½d. per sq. ft. area covered.

65 ft. Composite Corridor Carriages; Caledonian Railway.

The Caledonian R. Co. have lately built some new trains for their service between Glasgow and Edinburgh and Perth and Aberdeen. They are composed of corridor carriages 65ft. long over the bodies and 68ft. 6ins. over the buffers, and which were designed by Mr. J. F. McIntosh, M.Inst. C.E., locomotive carriage and wagon superintendent of the Caledonian R., and to whose courtesy we are indebted for the drawings from which our illustrations have been made. The carriages were built at the company's works at St. Rollox, Glasgow. They are fitted with every convenience, including hot and cold water in the lavatories, and form the finest trains ever built for purely Scottish traffic. The carriages are connected by gang-



65ft. Composite Corridor Carriages ;

ways throughout. They are fitted for steam heating and electric light (Stone's system).

The train is known as the "Grampian" express, and leaves Buchanan Street Station, Glasgow, at 10 a.m., and Prince's Street Station, Edinburgh, at 9.25 a.m., and returns from Aberdeen at 5.25 p.m. In a subsequent issue we shall publish further drawings of these fine carriages, accompanied by a detailed description of them. The weight of one of these composite corridor carriages is 37½ tons.

Railways in India; Administration Report for 1904.

The Railway Board in issuing the report for 1904 have considerably reduced it in size by omitting statistics (appendices 4, 6, 12 to 16, 19 to 21, 36 and 37) that appeared of no practical use.

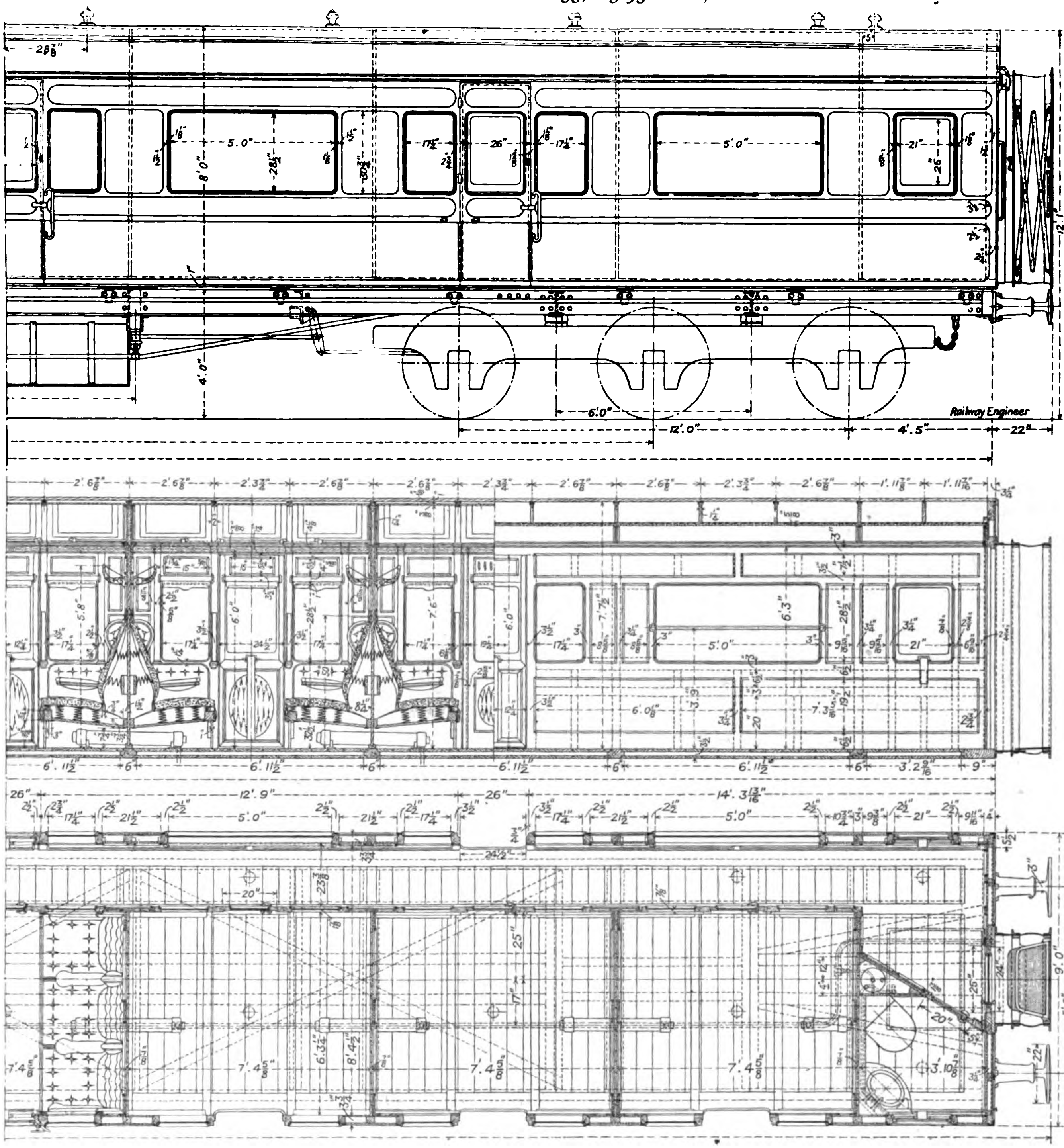
One new table (Appendix 39) of purely academic interest to the railway world has been added, showing the comparison of the division of working expenses on the principal railways for goods and passengers proportionately for receipts, ton-miles, and train-miles of each.

During the year 1904, 621 miles of line were opened to traffic, bringing up the total mileage to 27,565 miles of the following gauges :—14,733 of 5ft. 6in. gauge; 11,562 of 3ft. 3⅜in. gauge; 942 of 2ft. 6in. gauge; 328 of 2ft. gauge.

There were 850 miles of line sanctioned during the year, viz. :—306 of 5ft. 6in. gauge; 212 of 3ft. 3⅜in. gauge; 251 of 2ft. 6in. gauge; 81 of 2ft. gauge.

Up to the latest date of returns (end of April, 1905) the total length of lines open was 27,904 miles, and under construction and sanctioned 3,055 miles.

The capital outlay on open lines and lines partly open amounted at the close of the calendar year 1904 to Rs. 35,285·95 lakhs, and that on lines wholly under construction

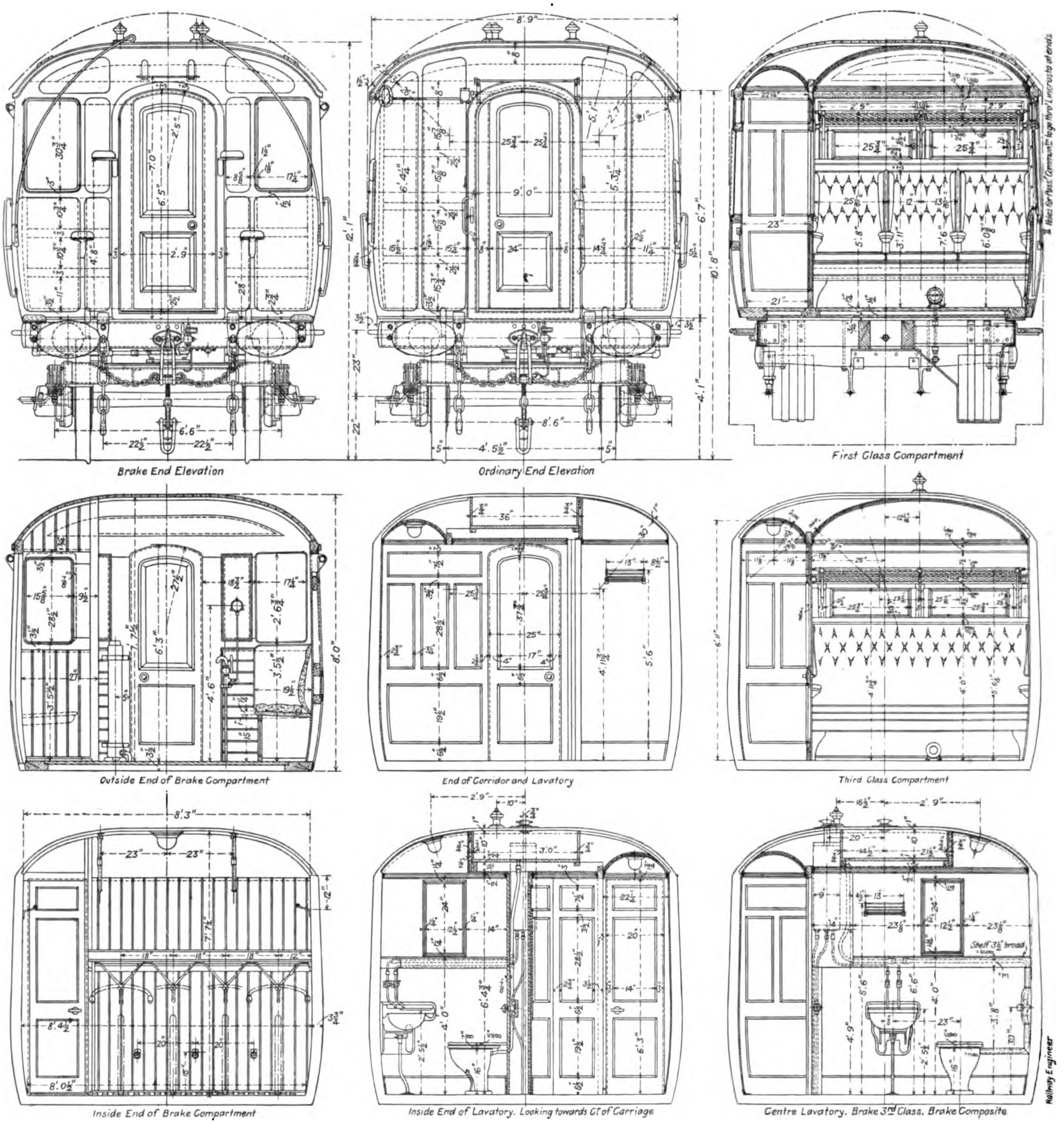


Caledonian Railway.

to Rs. 261·91 lakhs. In addition Rs. 88·36 lakhs were incurred on miscellaneous items connected with railways. The total outlay amounted to Rs. 35,636·22 lakhs.

In 1904, 130 engines, 337 coaches and 4,868 wagons were added to the rolling stock of the railways, and there are under supply 360 engines, 1,408 coaches and 4,376 wagons. Subsequent to the 31st December, 1904, the provision of 103 engines, 165 coaches and 2,026 wagons has, in addition, been authorised. 270 engines, 669 coaches and 875 wagons were fitted with automatic brakes, bringing the number so fitted at the close of the year up to 2,630 engines, 10,401 coaches and 2,883 wagons, as against 2,929 engines, 9,491 coaches and 105,281 wagons *not fitted*; 656 vehicles were fitted with gas and electricity, bringing the total number so fitted at the close of the year up to 9,870 (of which 9,385 were fitted for gas) as compared with 7,622 not fitted; 151 stations were fitted with apparatus for interlocking points and signals. The progress in the introduction of automatic instruments for signalling trains between stations continues, 92 stations having been provided with these instruments.

With an addition of 621 miles to the open mileage, the gross earnings of all Indian railways, during the calendar year 1904 compared with 1903, amounted in round figures to Rs. 3,964·97 lakhs against Rs. 3,600·82 lakhs, an increase



Cross Sections and End Views of 65ft. Corridor Carriages; Caledonian Railway.

of Rs. 364·15 lakhs. Of the increase in the earnings, Rs. 166·41 lakhs were absorbed in additional working expenses. The net earnings amounted to Rs. 2,087·47 lakhs against Rs. 1,889·73 lakhs, or an increase of Rs. 197·74 lakhs. These net earnings yielded a return on the capital outlay on open lines and lines partly open (Rs. 35,285·95 lakhs) of nearly 6 per cent., which is an improvement of about ½ per cent. over the return yielded in 1903.

Of the increase of Rs. 364·15 lakhs in the gross receipts, the North Western S.R. earned Rs. 129·98 lakhs or 36 per cent., the East Indian R. earned Rs. 60·64 lakhs of 17 per cent., and the remainder was contributed principally by the Bengal-Nagpur, Great Indian Peninsula, Madras, Burma, and Southern Mahratta Rs.

The development of passenger traffic noticed in the last report, continued during the year under review, and a larger number of pilgrims, native marriage parties, visitors to fairs, etc., were carried by railway. The total number carried was 227,100,000 against 210,230,000, and the earnings therefrom Rs. 1,176·20 lakhs against Rs. 1,098·14 lakhs. The number of third class passengers carried was more by 15,360,000 and the earnings by Rs. 73·32 lakhs. The other classes also showed satisfactory increases. Of the increase of Rs. 78·06 lakhs in the passenger receipts, the Great Indian Peninsula R. earned Rs. 15·53 lakhs or 20 per cent., and the remainder was contributed principally by the Bengal-Nagpur, North Western State, Bombay, Baroda, and Central India, and Oudh and Rohilkhand S. Rs.

The average rate charged to passengers per mile was 2½ pies, just over 1-5th of a penny, and the average distance travelled was about 40 miles. There have been no material fluctuations in these figures since 1884.

The aggregate tonnage of goods lifted during the year 1904 and the earnings therefrom were 52,050,000 tons and Rs. 2,518·81 lakhs respectively; an improvement over the previous year of 4,370,000 tons and Rs. 276·89 lakhs. Of the increase in the goods receipts, the North Western S. R. earned Rs. 123·85 lakhs or 45 per cent., the East Indian R. earned Rs. 56·60 lakhs or 20 per cent., and the remainder was contributed principally by the Bengal-Nagpur, Madras, Burma, Southern Mahratta, Oudh and Rohilkhand State and Rajputana-Malwa railways.

The total weight of the traffic in grain and pulse, cotton (raw and manufactured), coal, oil-seeds, sugar, salt, and jute during the year 1904 amounted to 27,770,000 tons and the earnings therefrom to Rs. 1,689·81 lakhs against 24,920,000 tons and Rs. 1,489·37 lakhs in the previous year. The traffic in these commodities amounted during the past two years to about 71 per cent. both in weight and in earnings of the total traffic carried for the public.

There was a large increase of 1,180,000 tons and Rs. 123·77 lakhs in the wheat traffic included under grain and pulse, which is chiefly attributed to good crops and to an increase in the export demand. A brisk export trade in linseed and rape and mustard seeds increased the traffic under oil-seeds by 165,000 tons and Rs. 16·62 lakhs. Under grain and pulse, rich in the husk also showed an increase of 225,000 tons and Rs. 11·32 lakhs, consequent on a bumper harvest in Burma and a brisk movement of the commodity to Bombay. There was a falling off in the outturn in the cotton producing districts of India in consequence of unseasonable rains, which resulted in a decrease of 11,000 tons and Rs. 18·83 lakhs in the traffic carried by railways.

During 1904 the total output from the collieries in India and Burma amounted to 8,230,000 tons against 7,440,000 tons in 1903. The exports of Indian coal to Indian ports, principally Calcutta to Bombay, Karachi and Madras, rose from 1,240,000 tons to 1,450,000 tons or by 210,000 tons, and those to ports outside India, including Burma, from 723,870 tons to 896,880 tons, or by 173,010 tons, principally Calcutta to Rangoon and Ceylon. The imports of coal from the United Kingdom rose from 133,710 tons to 174,710 tons, or by 41,000 tons, and those from other countries from 30,430 tons to 79,170 tons, or by 48,740 tons. This was probably due to the fall in value of coal in England and low freights.

The total quantity of Indian coal consumed by railways during the year 1904 increased from 2,200,000 tons to 2,450,000 tons, or by 250,000 tons, while the amount of foreign coal consumed fell from 17,700 tons to 17,430 tons.

The improvement in the traffic in coal carried by railways was due principally to the increase of 604,490 tons and Rs. 20·34 lakhs recorded by the East Indian railway, owing to larger despatches from colliery stations for foreign railways and for export. On the Bengal-Nagpur railway the quantity carried increased by 106,250 tons, but the earnings were less by Rs. 1·12 lakhs. The increase in weight is partly accounted for by heavy consumption on railways and by private factories and partly by greater demand in Calcutta for shipment, while the decrease in earnings occurred because the Bengal-Nagpur railway were not permitted to quote below Government minimum rates, and consequently the Radhanagar coal for export was carried over the East Indian railway route *vià* Asansol.

The average rate for all descriptions of goods carried per ton per mile, viz., 5½ pies, or just under ½ penny, was the lowest recorded since 1884, in which year the rate was 7¾ pies; while the average distance over which a ton of goods was carried, viz., 172 miles, was the highest.

The additional mileage worked, the larger traffic handled and the increase in the train-mileage run, necessitated a corresponding increase in the working expenses, and although large sums were expended by the principal railways in renewing their permanent-way and rolling-stock, and in strengthening bridges and repairing damages caused by floods, the railways were worked during 1904 at a slightly lower percentage of gross earnings, viz., 47¼ against 47½ per cent. in the previous year.

The financial result for the year 1904 was a net gain to the State of 263·22 lakhs of rupees, the largest yet obtained in any year, after meeting, in addition to the expenses of working, all charges for interest on capital outlay by the State and on capital raised by companies, and also the annuity payments for railways purchased by the State, including both interest and the portion that represents redemption of capital. This is the fifth year in succession in which there has been a surplus.

As the outcome of a proposal made by Mr. Thomas Robertson, C.V.O., in his report on the working of Indian railways, His Majesty's Secretary of State for India sanctioned the formation of a Board, consisting of a chairman and two members—with the necessary clerical establishment—to whom is entrusted the general control and administration of the railways in India, hitherto exercised by the Government of India in the Railway Branch of the Public Works Department. Mr. F. R. Upcott, C.S.I., has been appointed chairman, and the two members are Mr. W. H. Wood and Mr. T. R. Wynne, C.I.E., with Mr. Neville Priestley secretary. These gentlemen assumed office in March, 1905.

There was an increase of 12 in the total number of persons killed from all descriptions of accidents during 1904 as compared with the previous year, but a decrease of 52 in the number injured.

The total number of persons of all classes killed by causes beyond their control was 40 against 77, and the number injured 201 against 218. Out of a total of 227·10 millions against 210·23 millions of passengers travelling, and of 9,006·85 millions of miles against 8,389·91 millions of miles travelled, 11 passengers were killed and 83 injured against 50 killed and 116 injured. This gives an average of one fatal casualty in 20·65 millions against one in 4·20 millions of persons travelling; and an average of one in 818·80 millions against one in 167·80 millions of miles travelled in 1904 and 1903 respectively.

The total number in railway employ at the close of the

year was 421,866, of which 6,293 were Europeans, 8,765 Eurasians and 406,808 natives. Of the Europeans and Eurasians 12,808 were enrolled as volunteers.

The police force employed for the maintenance of law and order on railways and for the protection of railway property is provided by the Civil Department, the State bearing, except in the case of State lines worked by the State and the old Guaranteed railways, three-tenths, and the railways paying seven-tenths of the expense incurred.

Enlarging and Remodelling of Victoria Station London, Brighton and South Coast Railway.

By Chas. S. Lake.

The conversion of the London, Brighton and South Coast Company's main line between London and Brighton from its former condition, in which double-line sections predominated, and joint working with another company over one of the most important lengths was involved into an almost entirely independently controlled four-line road, equipped throughout on the most modern principles, is proceeding as rapidly as possible, for works of such a difficult character, without disturbing unduly the traffic. Commensurate with the progress of this extensive undertaking a work of equal importance is being pushed forward by the Company in the reconstruction and enlargement of their West End terminus at Victoria.

The two projects are being developed conjointly, under the supervision of Mr. Chas. L. Morgan, M.Inst. C.E, engineer-in-

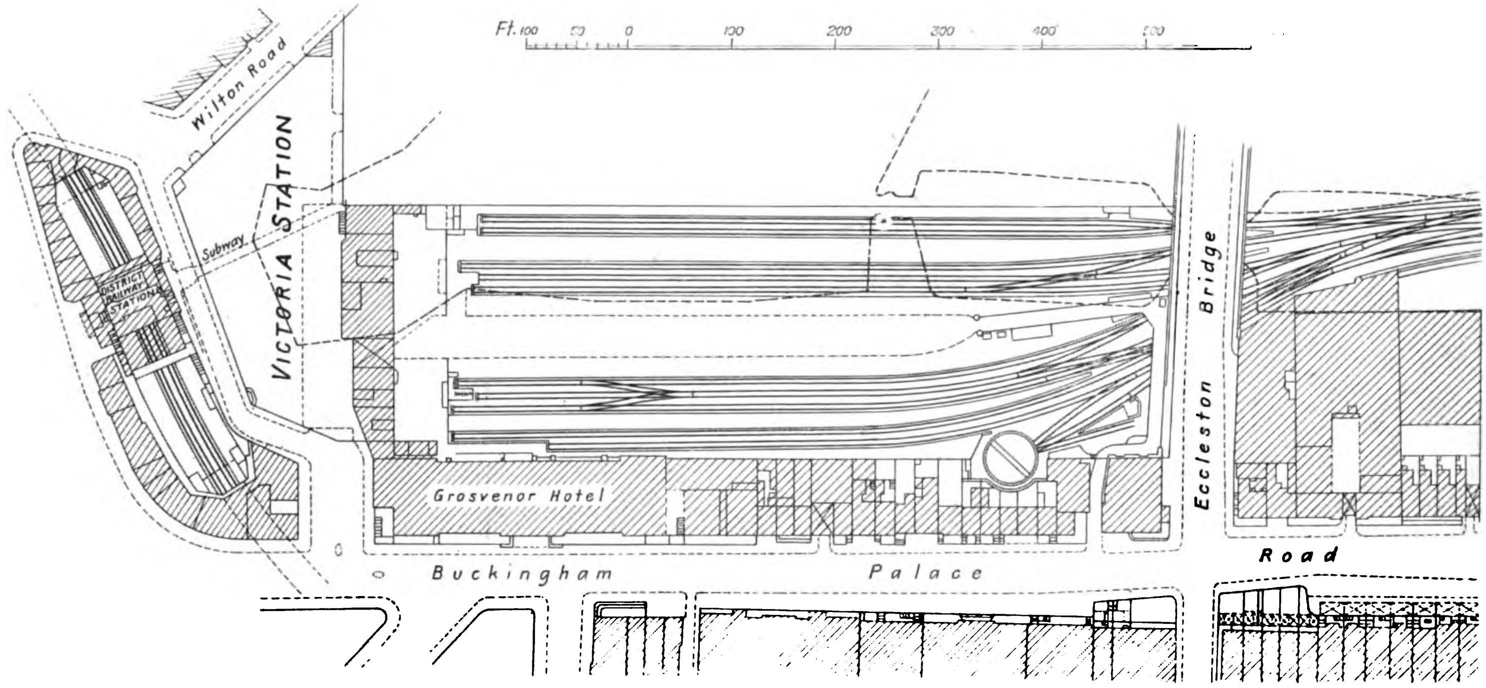


Fig. 1.—Plan of Existing Terminus at Victoria.

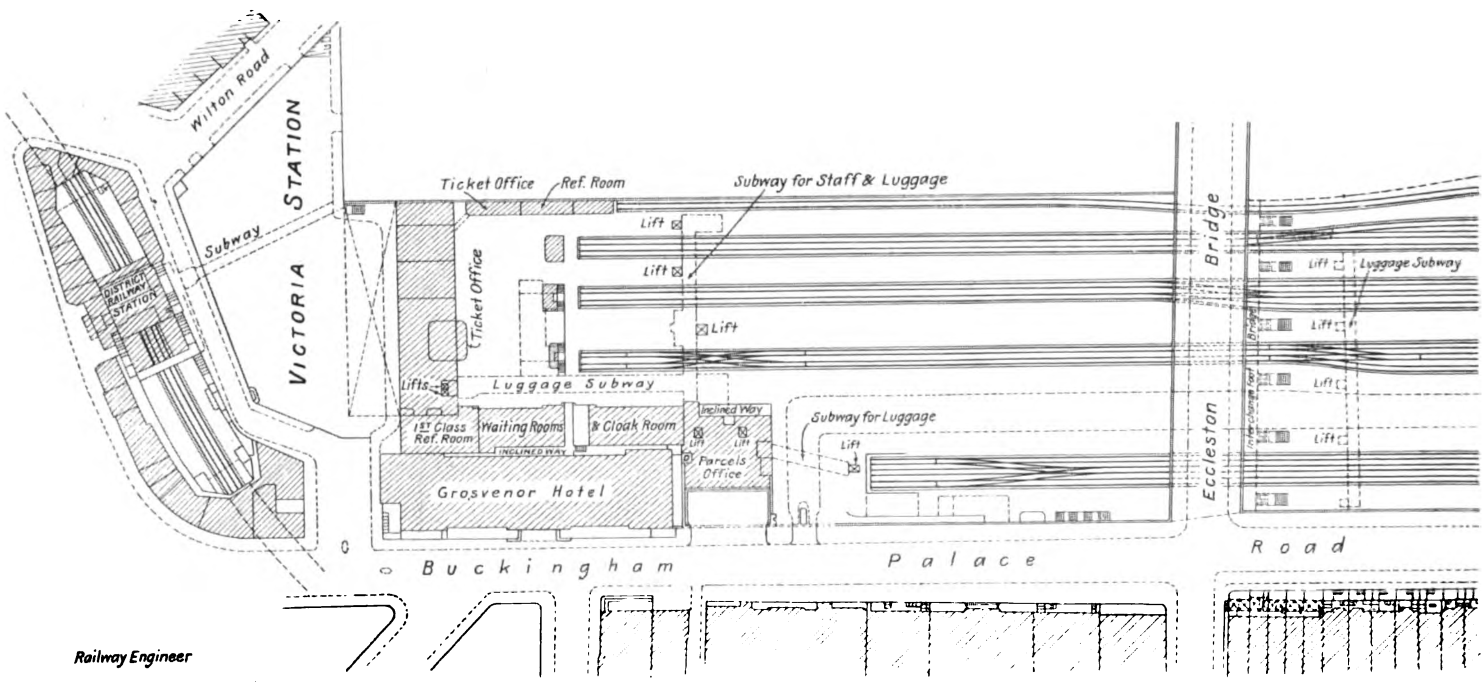
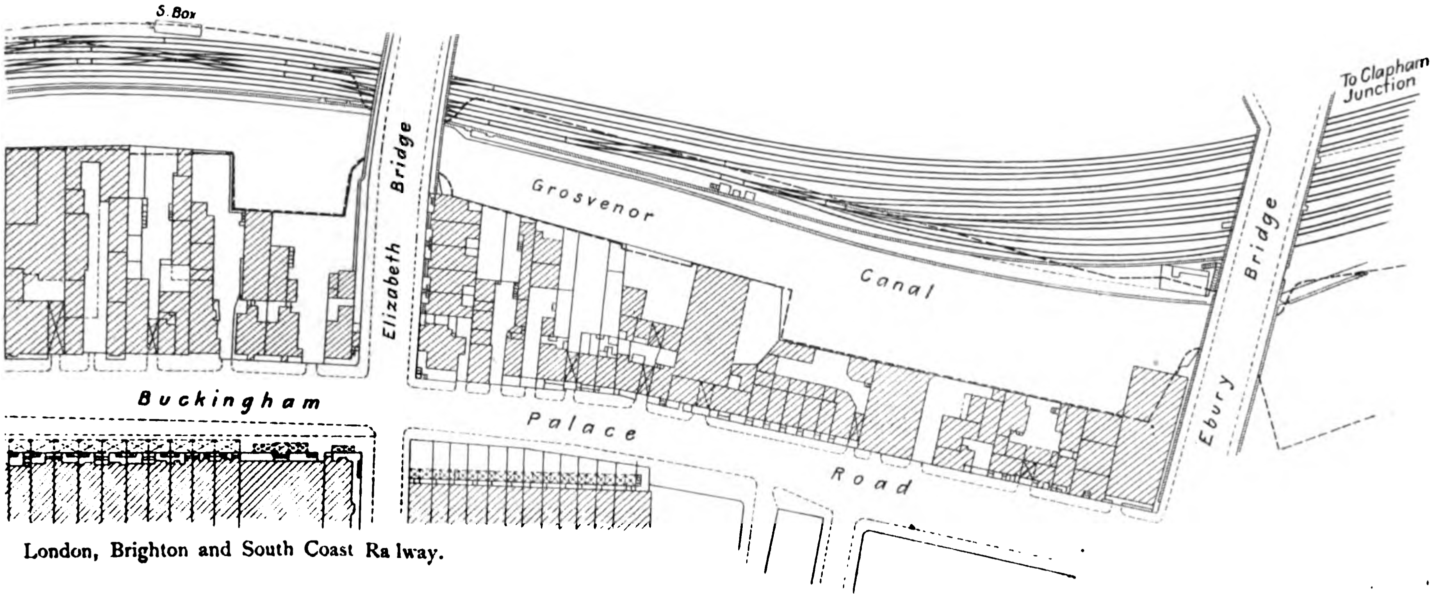


Fig. 2.—Plan showing Victoria Station as it will be when completed.

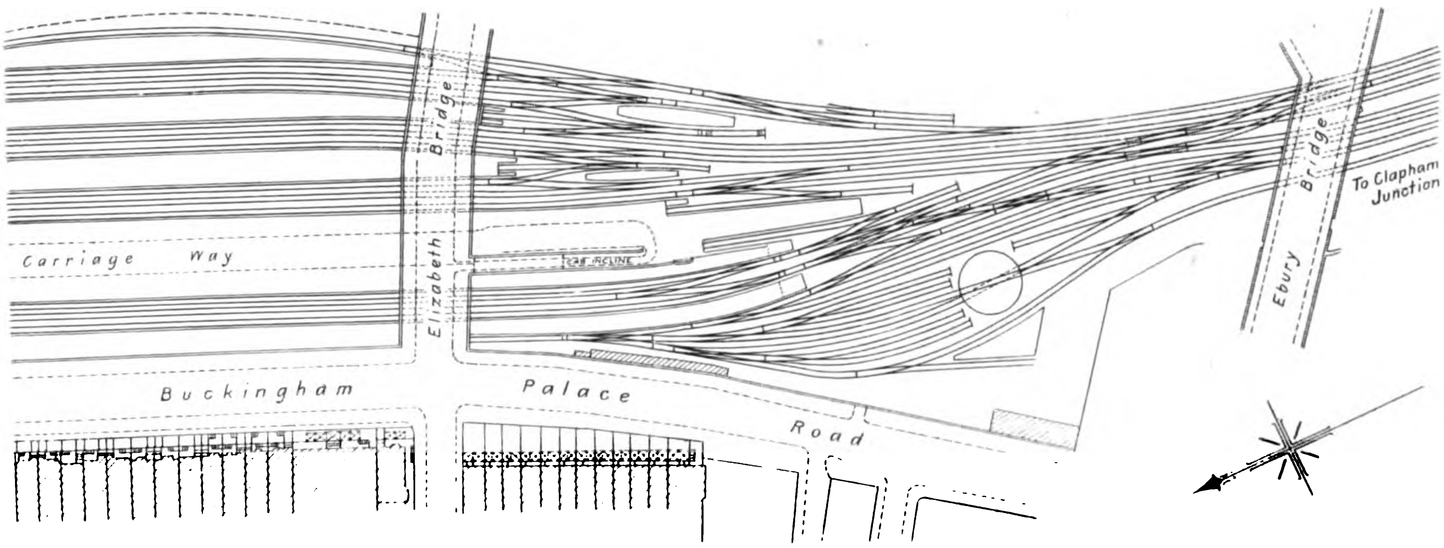
chief of the London, Brighton and South Coast R., to whose courtesy the writer is indebted for permission to view the works at Victoria, and to whom thanks are also due for the photographs and drawings from which the accompanying illustrations have been prepared.

The completion of the two schemes—*i.e.*, the main line widening and the rebuilding of Victoria Station, will have the effect of providing not only one of the finest and most up-to-date terminal stations in the Metropolis, but also with a vastly improved railway second to none as regards equipment and permanent way. These improvements, coupled with the fact that more powerful locomotives are at present building for the Brighton service, will materially assist in still further increasing the popularity and accessibility of Brighton itself, and will also enable a scheme in connection with long distance suburban traffic to be developed, and which, it is confidently believed, can be made to show specially remunerative results when the improved facilities have become available.

The work of remodelling Victoria Station involves not only the addition of new platform and other accommodation on a large scale, but also the entire reconstruction of the existing terminus, comprising the practical demolition of the latter (including the roof) and a complete re-arrangement of the platforms, lines, offices, &c. The completion of the works will effect the removal of the present inconvenient arrangement of lines by which all trains entering or leaving the station have to pass through a "bottle neck," comprised of only one up and one down road with a siding in addition, and the substitution of a straight through four-line (two up and two down) system, giving access to any part of the enlarged station as a whole. In the new (or South) station, as it will be called, there are three roads between the platforms, the centre one being provided for the purpose of transferring empty stock and similar uses. These middle roads communicate with the platform tracks in the existing (or North) station, so that it will be possible to run trains either in or out of the latter during the time that others are loading or unloading at the platforms in



London, Brighton and South Coast Railway.



London, Brighton and South Coast Railway.

the South portion. In like manner, trains having arrived at and unloaded at these platforms, may be drawn ahead clear of the Junction, thus making room for other incoming trains, the empty coaches then passing out along the middle road. Thus a great deal of delay and inconvenience will be avoided and the station work generally expedited.

The inadequacy of Victoria Station to accommodate the traffic is well known, but as the new terminus which Mr. Morgan has designed comes into use this will pass away, and the travelling public will have every reason to be quite satisfied.

Although it is correct to describe the station as consisting of the Southern portion. Fig. 1 is a plan of the old station as it existed before the alterations commenced, and Fig 2 is a plan of the new station; from the latter it will be seen that the station is crossed at two points in its length by two over-bridges leading on the Western side, out on to the Buckingham Palace Road. These are respectively known at Eccleston and Elizabeth Bridges, and the former marks the end of the North and the commencement of the South portions of the terminus. Both of these bridges have been entirely reconstructed and the continuous, or cantilever principle has been employed in connection with them. The girders are encased in concrete, as a protection against the dele-

Fig. 3.—Bay on Western Side of Station looking North, October, 1904

two portions it must be understood that the terminus is to be regarded as a whole and as one for all practical purposes, no division of a physical nature existing to disturb the direct continuity of the platforms and tracks (with certain reservations on the western side) from one end of the building to the other, whilst a broad carriage way extends from the extreme southern end to a point near the Grosvenor Hotel at the north end, where an outlet is provided giving access to the Buckingham Palace Road, to which feature further reference is made subsequently in this article.

Some idea of the magnitude of the scheme of reconstruction may be gathered from the statement that whereas the old station was 230 ft. wide and 800 ft. long, the new one will be 320 ft. wide and have platforms 1,500 ft. in length. There will be 9 platforms in all, with 10 roads in the Northern and 14 roads in terious effects of the smoke from the locomotives. In order to provide sufficient head room over the lines on the Western side of the station, the level of the bridges referred to had to be raised by some 6 feet, but by employing specially designed girders, seen in fig. 4, the height above rails of the main portion of the bridge floor was kept as shallow as possible, thus avoiding too steep approaches from the adjoining roadways. This part of the work necessitated raising part of the Buckingham Palace Road and also certain streets adjoining it; the gradient of the main road now being 1 in 40 and of the other streets involved 1 in 30. The boundary wall of the Company's property abuts on the Buckingham Palace Road throughout the length of the station on the Western side, except of course where the bridges intervene, and a wholesale demolition of property, extending from the south of the Grosvenor Hotel to Ebury Bridge, was necessary. The property

Fig. 4.—Bay on Western Side of Station looking North, March, 1905.

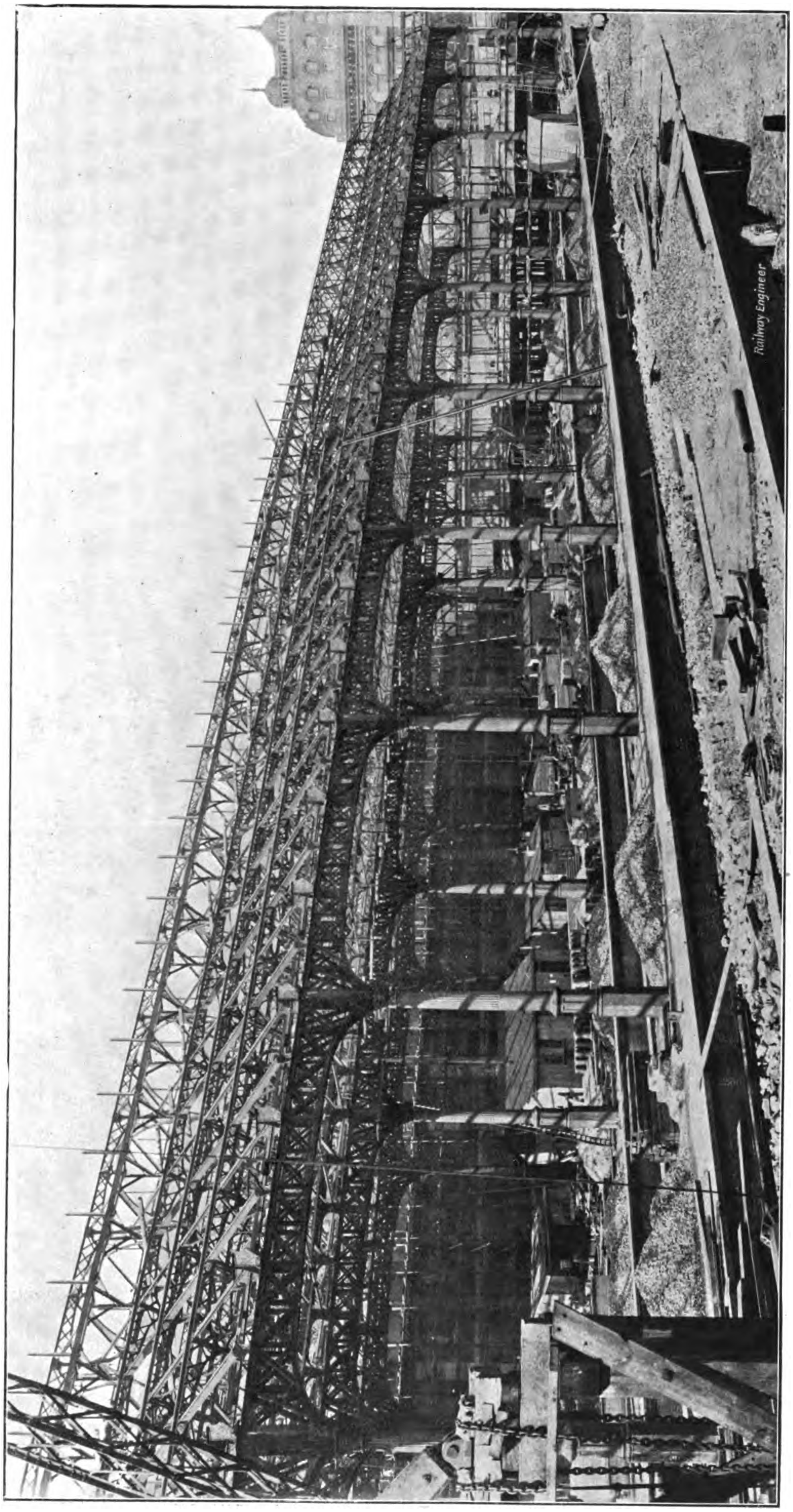


Fig. 5.—General View of South Station, March, 1905.

destroyed consisted of buildings of an unimportant type, with the exception of the old-established Pimlico Wheel Works. In carrying out this portion of the undertaking the Company have introduced several material improvements in widening and straightening the Buckingham Palace Road, whilst the erection of a handsomely designed wall, fig. 7, 30 feet in height, and largely constituted of Portland stone, in place of the irregular range of buildings, will still further improve this portion of the thoroughfare.

The old station, fig. 1, had only one way by which cabs and private vehicles could enter and leave it. This consisted of a somewhat narrow passage way connecting the arrival yard with the interior of the building, and as it was obligatory on all vehicles coming in from the road or passing out thereto from the station to use this, great congestion, causing at times considerable inconvenience and annoyance, naturally ensued.

In the new station this will be entirely done away with by the provision of the new carriage way and outlet already referred to, whilst the passage which originally did duty for vehicular traffic going in both directions, viz., in and out of the station, will be exclusively reserved for incoming vehicles only. The yard or forecourt outside will be widened by about 50 feet by taking in the space at present occupied by booking offices and waiting rooms.

Cabs, carriages, &c., entering the South Station will do so from Elizabeth Bridge by means of an inclined way from the bridge to the level of the platforms. They will proceed along the carriage way between the main line platforms as shown on fig. 2. This roadway leads to an outlet giving access to the Buckingham Palace Road at a point near the South end of the Grosvenor Hotel, an imposing archway having been erected to cover the exit, with a large parcels office and van circulating space adjoining.

The hotel itself has been extended across the station, thus forming a wing or annexe of considerable proportions, measuring 290 ft. by 70 ft. Under this, on the space now occupied by bookstalls, the new booking offices will be erected.

About 1,200 wooden piles, 14 ins. square, have been used for the foundations of the new wing, which will be carried upon steel stanchions and girders. The piles have been driven to a depth of 40 ft. below platform level, at which depth London blue clay is reached.

Passengers leaving by train will enter the station at the North end as at present, and here, in addition to the new booking and other offices which are to be erected, a large parcels office and cloak room will be established, in connection with which underground subways for luggage are provided. These subways are fitted with lifts at every platform. All luggage arriving at the North Station booking hall will be labelled according to its destination and then lowered into the subway to be conveyed direct to the platform from which its particular train is to start, where it will be raised by lifts and transferred to the luggage vans. This system has been installed with the commendable object of keeping the circulating area before the bookstalls and entrance to the platforms free from accumulations of baggage such as are usually to be observed at nearly all large terminal stations, both in London and elsewhere, and which tend to create very great inconvenience to passengers and others using the premises. A similar subway system is provided at the South Station, so that passengers arriving by main line trains and wishing to depart by suburban trains will be enabled to get their luggage transferred from one platform to another without experiencing the usual amount of inconvenience and delay.

Each of the platforms in the South Station is provided with a staircase communicating with a covered way extending across the full width of the station and giving direct access to Eccleston Bridge, or by walking through into the North Station the cab outlet into Buckingham Palace Road, previously referred to, becomes available for the use of passengers leaving the station on foot.

The plan and other illustrations are sufficiently clear to be self explanatory as to the general scheme of the station and its approaches, and to show the progress of this extensive undertaking at various stages.

The engine turn-table has been removed from its original position at the South end of the old station to a point clear of the extension works. The space around here was previously taken up by a portion of the Grosvenor Canal, which at one time ran right up to Eccleston Bridge. This canal has been cut off by a dam wall built across it, the bed having been filled in and the space used as part of the approach to the station and as siding room. A building, comprising a drivers' and firemen's mess room, Westinghouse brake room and lavatory accommodation, has been erected near the turn-table, and engine and carriage docks are located in the vicinity. The turn-table and lifts will be operated by electricity, and the station and yards will be lighted by this means.

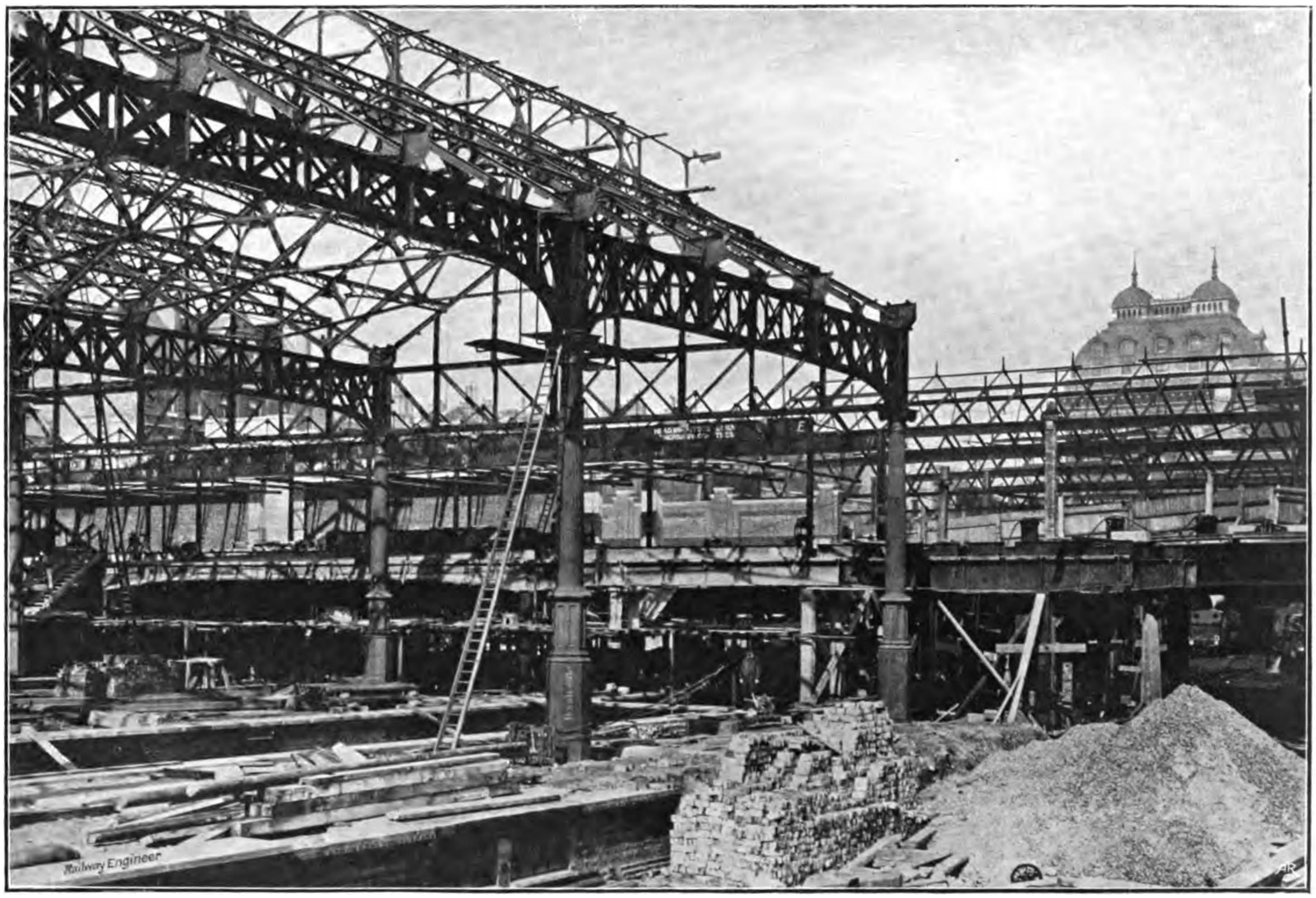


Fig. 6.—View showing point at which Eccleston Bridge divides North from South Stations.

As regards the material employed in the construction of the station, the boundary walls, &c., are mostly in Leicester red brick relieved with massive white stone facings, and the platforms are of brick, with granolithic stone coping.

The roofing over the new station is divided into two parts by the bridge carrying Eccleston Road across the station. The area

covered by the roofing to the North of this bridge is about 187,000 sq. ft., or somewhat over $4\frac{1}{4}$ acres, whilst that on the South side is about 16?,000 sq. ft. or $3\frac{3}{4}$ acres; making a total covered area of 8 acres. The northern portion is divided into 5 bays by lines of columns; the spans or these bays commencing from the South-Eastern and Chatham Company's boundary, and being 72 ft. 4 in., 53 ft. 2 in., 54 ft. 4 in., 60 ft. 6 in. and 77 ft. respectively. The last of these bays does not extend to the extreme northern end of the platforms, but terminates at the new parcels office.

The width of the southern portion is also divided into 5 bays, of which that next to the S.E. and C.R. is of varying span, to suit the curve on that side of the station, and is constructed with ridges and valleys transverse to the other bays, which are respectively 59 ft. 4 in., 56 ft. 10 in., 54 ft. 4 in., and 67 ft.

The columns supporting the roof are generally 50 ft. apart centre to centre longitudinally, between which and supported by them are the girders which carry the roof principals. The latter are 16 ft. 8 in. apart centre to centre, with braced purlins between them carrying an intermediate rafter midway between the principals.

At each side of the Eccleston Bridge the main roof is interrupted, and a longitudinal ridge and furrow construction is employed for covering in the irregular spaces between the bridge and the main roof.

Beyond these the main roof is terminated by gable ends, but at the Northern end, where it abuts on the new booking offices and hotel annexe, the ends are hipped down to the top of the new booking hall. The carriage way from the South side of Elizabeth Bridge to the bottom of the cab incline will be roofed over, and the two platforms on the west of the incline will also be covered for a distance of about 200 feet from the south side of the bridge.

The chief contractors for the entire work of reconstructing the station are Messrs. Mowlem and Company, of Westminster.

Before bringing the article to a conclusion the writer desires to express his thanks to Mr. F. B. Brown, Assoc. M.Inst.C.E., the resident engineer, who, at Mr. Morgan's request, kindly afforded the desired information on the spot. It should be added that, in spite of the immense difficulties attending the work and the magnitude of the operations involved in its execution, no interference with the ordinary traffic has occurred. The usual services of trains have been maintained throughout in connection with the existing station, a fact which reflects credit upon everyone concerned.

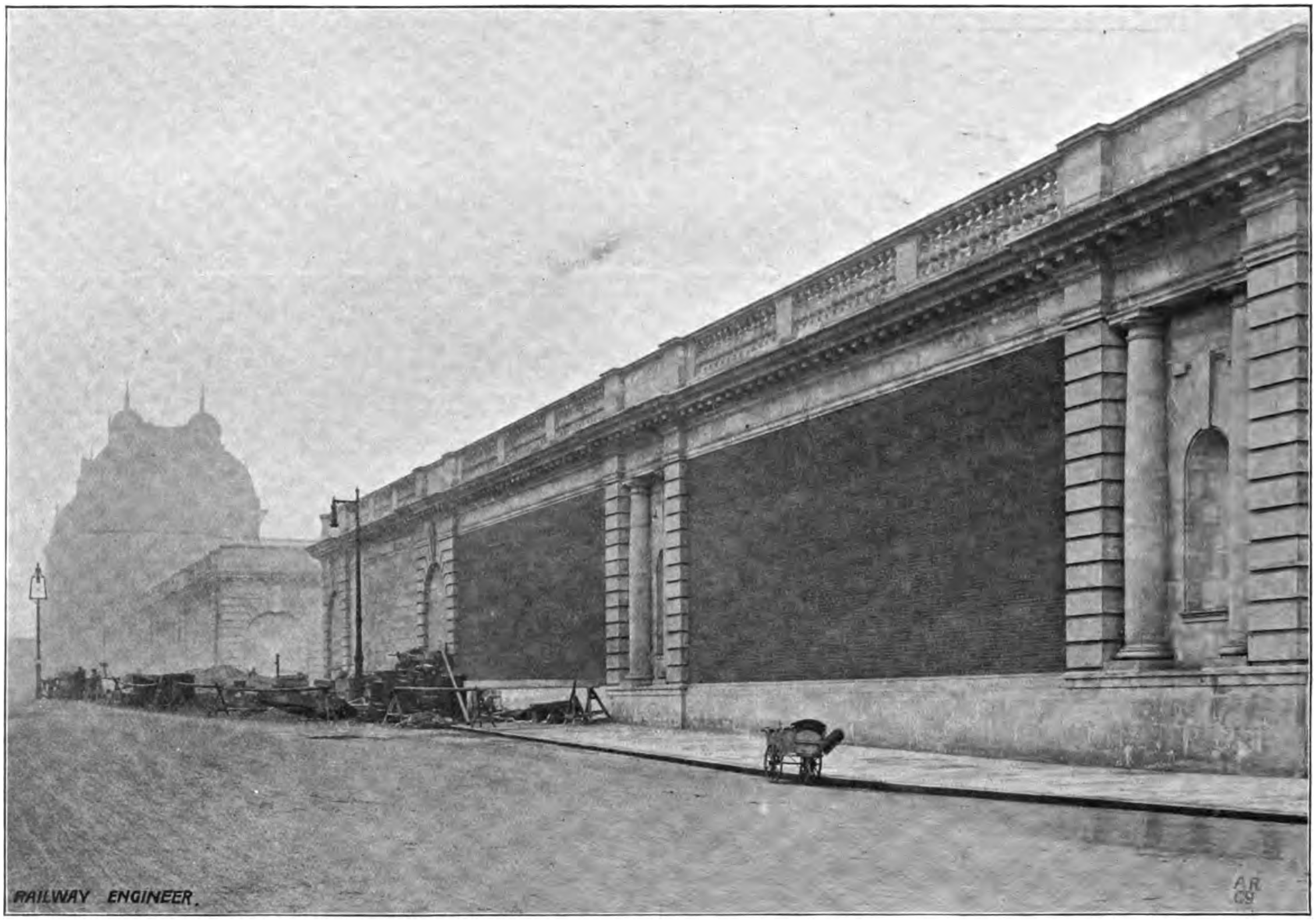


Fig. 7.—Boundary Wall, Buckingham Palace Road.

Full detail drawings of the roofing will appear in *The Railway Engineer* for September.

With regard to the signalling and interlocking, it has been decided to adopt the Sykes Electro-Mechanical System, to which further reference may be made on a future occasion.

Baldwin Four-Cylinder Balanced Compound Locomotives.*

The prevailing conditions in railroad passenger traffic demand the highest practicable rate of speed with the heaviest possible load. Trains with loads of from 300 to 600 tons behind the engine are required to attain a sustained speed of at least 50 miles per hour, and those of 200 to 300 tons a speed of 60 miles per hour. Instances may be cited where, in order to maintain the schedule time, it is necessary to cover a distance of nearly 40 miles, on comparatively level track, at a speed of 80 miles per hour, and this, not for one day, but every day in the year.

That a single expansion locomotive, properly designed, can do this work is not denied; but experience has shown that the dead weight required for such a locomotive, the increased strains and internal friction, together with the difficulty in properly counterbalancing the driving wheels, is liable to make the wear and tear on the track excessive. Aside from these difficulties the firing of the locomotive under such conditions becomes a question of moment, as it is practicably impossible for one man to handle the necessary amount of coal to keep up the requisite steam.[1]

The advantages that are obtained from compounding the steam used in a locomotive are well-known, but they may be briefly stated as follows:—

1. Greater efficiency of boiler, for the reason that proportionately less steam is used than in single expansion locomotives. A lesser rate of evaporation is required.

2. A lighter final exhaust to the chimney, by which means a more complete and slower rate of combustion is maintained.

3. A higher boiler pressure can be advantageously used, and consequently drier steam obtained.

4. A greater range of expansion is obtained because the initial pressure is higher and the exhaust pressure is lower than in single-expansion cylinders. As the expansion is divided between two cylinders, the relative temperature of the two will be higher and result in decreased cylinder condensation.

All of these advantages tend to give an economy in the use of fuel and water, which reaches to from 15 to 25 per cent., depending on the conditions of service. It has been maintained by some that the increased cost of repairs in the present types of compound locomotives more than offsets the amount saved by fuel economy. This criticism has led to further improvements, and the introduction of the Four-cylinder Balanced Compound Locomotive. It is claimed for the Baldwin design that it retains all the advantages of compounding and eliminates many of the disadvantages, and in addition provides a complete balance of both the revolving and reciprocating parts.

The first locomotive on the Baldwin four-cylinder balanced compound system was built in January, 1902, for the Plant System, and was the 20,000th locomotive turned out of the Baldwin Works after 70 years of continuous operation. This locomotive attracted much attention at the time, and its record was anticipated with widespread interest. It was, however, too heavy for use on the Plant System and was sold to the Chicago Short Line. It was of the 6-coupled bogie type with 15ins. and 15ins. x 26ins. cylinders; 6ft. 1in. diam. coupled wheels; 2,793 sq. ft. heating surface; 27·25 sq. ft. grate area; steel tubes and fire box; 127,000lbs. on coupled wheels, and 49,500lbs. on bogie. All cylinders work on to the leading coupled axle.

*Abstracts from "Record of Recent Construction," No. 49, issued by the Baldwin Locomotive Works, 1905.

[1]In this country these are hardly established facts yet.—Ed. *R.E.*

As is common to locomotives of this system, the l.p.-cylinders are placed outside the engine frames, connections being made with crank pins on the driving wheels. This is to avoid stressing the crank axle by the heavy pressure in the l.p.-cylinders in starting. The h.p.-cylinders are inside the frames in the same horizontal plane as the l.p., and connection is made with a cranked driving axle.

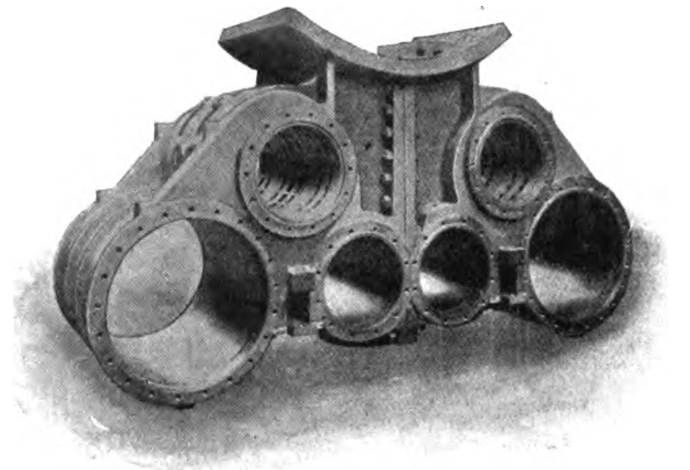


Fig. 1.—Cylinder Saddle.

The cylinder saddle, fig. 1, is cast in two parts and bolted together in the usual way, each half containing a high and low-pressure cylinder and a single valve which controls the admission of steam to both cylinders. This admits of the use of the ordinary Stephenson type of valve motion the same as is used in single-expansion locomotives. The valve, fig. 2., is of the piston type

Fig. 2.—Piston Valve.

with central steam admission, and slides in a machined bushing, fig. 3, which is forced into the cylinder saddle. A single reverse lever in the cab is all that is required.

The course of the steam from its admission to the h.p. cylinder until it reaches the final exhaust is shown by fig. 4.

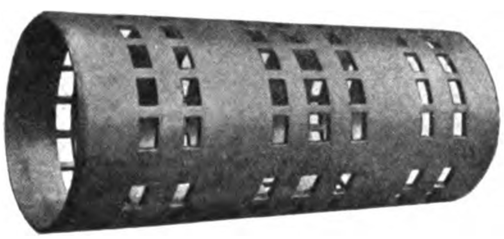


Fig. 3.—Valve Bushing.

The live steam port in this design is centrally located between the induction ports of the high-pressure cylinder. Steam enters the high-pressure cylinder through the steam port and the central external cavity in the valve. The exhaust from the high-pressure cylinders takes place through the opposite steam port to the interior of the valve, which acts as a receiver. The outer edges of the valve control the admission of steam to the low-pressure

cylinder. The steam passes from the front of the high-pressure cylinder through the valve to the front of the low-pressure cylinder, or from the back of the high-pressure to the back of the low-pressure cylinder. The exhaust from the low-pressure cylinder takes place through external cavities under the front and

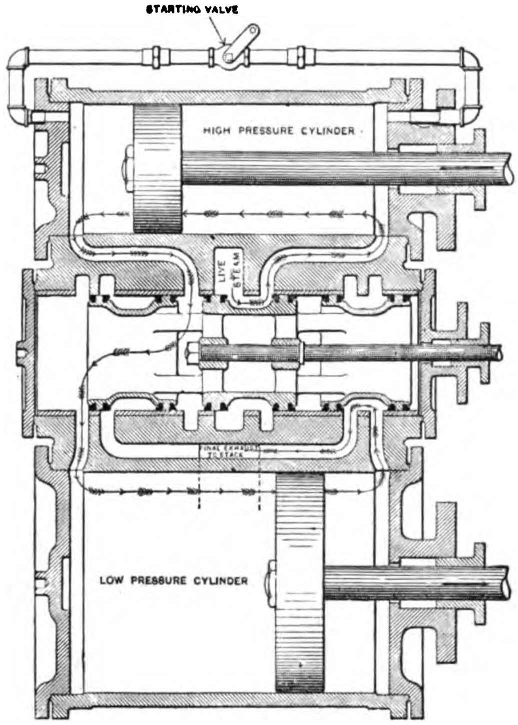


Fig. 4.—Steam Distribution in Balanced Compound Cylinders.

back portion of the valve, which communicate with the final exhaust port. The starting valve connects the two live steam ports of the high-pressure cylinder to allow the steam to pass over the piston.

Fig. 5 illustrates more fully the function of the counter-balance of the driving wheels of a locomotive. In each wheel, opposite the crank, is placed a certain weight, shown black, which denotes the exact equivalent of the weight of the revolving parts comprising the wrist pin, wrist pin hub, stub, one-half the coupling rod, and on the main pin two-thirds of the main rod. The two opposing weights exert the same force throughout the entire revolution, and balance each other.

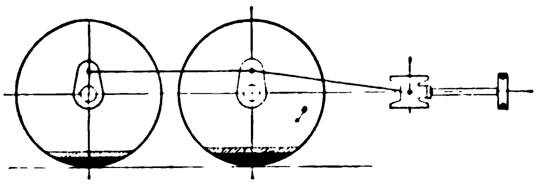


Fig. 5.—Diagram of Balance.

If the revolving parts were the only ones to be considered, the wheels could be easily balanced, but the reciprocating parts must be provided for. These, comprising a portion of the weights of the piston, piston rod, cross-head and front end of the main rod, exert a force in a horizontal direction upon the crank pin which is unequal during the revolution, being least when the pin passes the dead centre, and greatest when the half stroke point is reached. It is absolutely necessary to provide some means for balancing this weight, and in an ordinary locomotive an additional counterweight is placed on each driving wheel indicated on fig. 5 by shaded lines. This can be made to balance the parts exactly only at portions of the stroke, so that when the counterweight has reached one portion of the revolution there is no equivalent weight opposite, and with a heavy locomotive at high speed, with comparatively light rails, results as shown in the accompanying illustration may occur. Fig. 6 shows the condition of the rails on a section of track after an Atlantic type locomotive of ordinary construction had passed over it at a speed of about 80 miles per hour.

The road here, running over swampy land, had been changed from single to double track, consequently the foundation was more compact at the centre than at the outer portion, otherwise undoubtedly the effect noticed on the outer rail would have been apparent on the inner as well.

Fig. 7 shows the motion of a balanced compound "Atlantic" engine, built for the Chicago, Burlington and Quincy RR., and which has cylinders 15 ins. and 25 ins. by 26 ins.; coupled wheels 6 ft. 6 ins. diam.; heating surface 3,312·27 sq. ft.; grate area 44·14 sq. ft.; weight on coupled wheels 92,800 lbs.; total weight, 196,500 lbs. It differs from the one previously described, in that the main crank pin for the high-pressure cylinder is placed in the second instead of the first pair of driving wheels. On each side of the engine, while the reciprocating parts in connection with the high-pressure cylinder are moving in one direction, those in connection with the low-pressure cylinder are moving in the opposite direction. These parts having the same rate of speed,

Fig. 6.—Rail Depression caused by Imperfectly Balanced Locomotive.

and being practically of the same weight, exert an equivalent force in opposite directions at all points and balance each other. This leaves only the revolving parts to be compensated for in the driving wheels, and these can be exactly counter-balanced. The two pistons on each side of the locotive, travelling in opposite directions, equalise the longitudinal strains, and prevent what is termed the "nosing" action. This relieves the track from injury and adds to the safety of the locomotive and to the comfort of the engineer.

The strain upon the rail exerted by the unbalanced engine must be taken into consideration in estimating the safe wheel load which the rail can sustain. It is evident, therefore, that if this unbalanced feature is done away with the safe axle load can be increased, allowing greater weight to be carried on the driving wheels, resulting in the development of greater tractive power and the possibility of hauling heavier trains.

The arrangement of the coupling rods is as follows:—The crank on the axle and the crank pin in the driving wheel for the corresponding high and low-pressure cylinders are set at an angle

of 180deg., the two axle cranks being set at 90deg.; this brings the action of each high and low-pressure cylinder on one side of the locomotive, quartering with those on the other side, and four points of connection are provided, equally distributed about the central axis. This arrangement, to a great extent, neutralises the unequal rotative moments due to the angularity of the connecting rods. Four sets of rods, guides and pistons are used, but the strains are so distributed between them as to make it possible to lighten the weight of each and still have ample strength for maximum requirements. This division of the strains decreases the wear and tear on the moving parts and compensates for the increased number.

Locomotive No. 507, built for the Atchison, Topeka and Santa Fe, is one of 60 recently furnished that road, and which have 15ins. and 25ins. × 26ins. cylinders; coupled wheels 6ft. 7ins. diam.; heating surface 3,215sq. ft.; grate area 49·5sq. ft.; weight on coupled wheels 101·420lbs.; total weight 193,760lbs. It is a balanced compound Atlantic type locomotive, and formed part of the exhibit of the Baldwin Locomotive Works at the Louisiana Purchase Exposition. In this locomotive the four connecting rods are all connected with the front axle; the two outside from the low-pressure cylinders to the crank pins in the driving wheels, and the two inside from the high-pressure cylinders to the axle cranks. With this arrangement all the connecting rods are of the same length and practically the same weight, so that one set will balance the other. Although the rods are comparatively short, the vertical strains on the guides will not be as great as with an ordinary locomotive with much longer rod, for the reason that the thrust caused by the cylinder pressure is carried through two rods instead of one.

The balanced system of locomotives requires the use of a crank-axle, but in view of the fact that this style of axle is successfully used in foreign locomotive practice, it is reasonable to suppose that with the decrease in the strains brought about by the balanced compound principle, the prejudice against the crank-axle will be overcome. Every effort has been brought to bear to increase the strength of the axle and insure satisfactory results. Two different designs have been used, one is of nickel steel and forged in one piece. The centre or neutral axes of the crank pins are drilled and a 4in. steel pin is forced into the opening under hydraulic pressure and riveted over the cheeks. A steel band is also shrunk around the outer surface of each cheek.

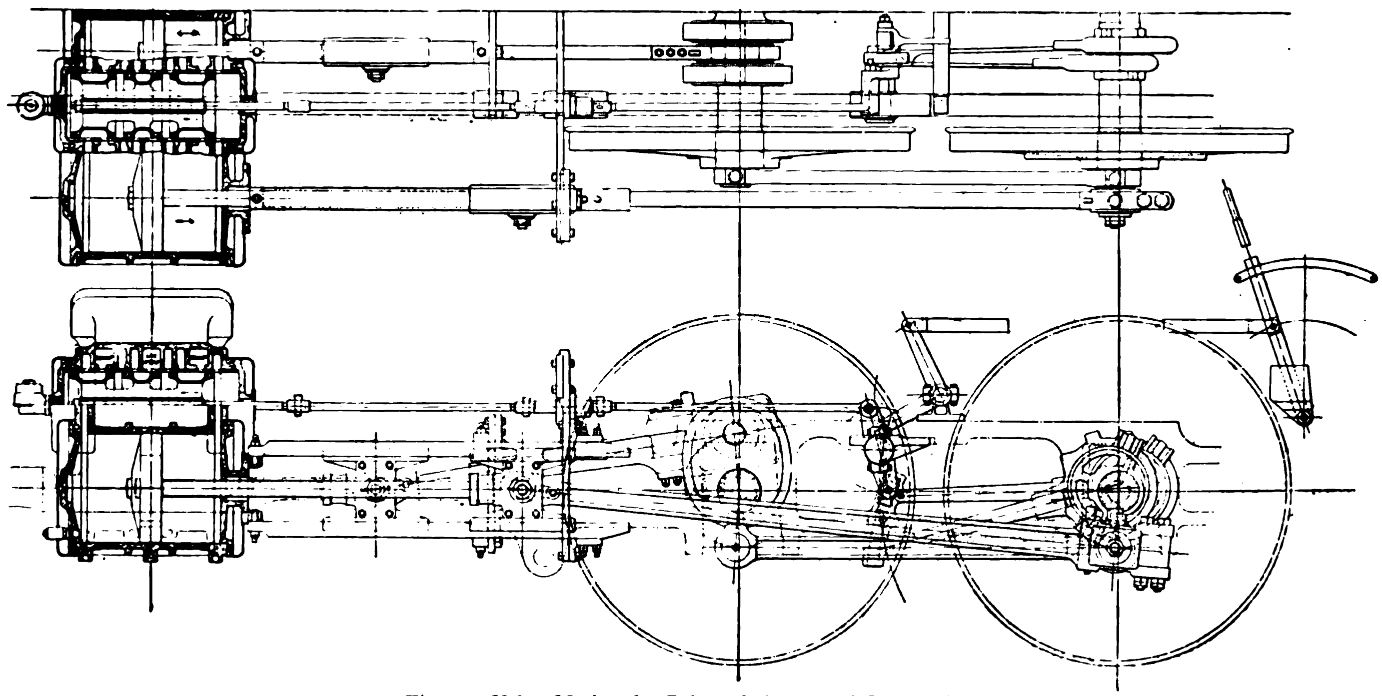


Fig. 7.—Valve Motion for Balanced Compound Locomotive.

Another form of axle is what is termed the "built-up" disk axle. It is in nine pieces forged separately. They consist of the three parts of the axle proper, the four disks which form the cheeks, and the two crank pins. Each of these parts is thoroughly forged, and after being machined they are forced together under a hydraulic pressure of one hundred tons, keyed and riveted over. This arrangement insures the direction of the grain to suit the strains brought upon the axle. Fig. 8 shows a built-up axle designed so that all the weights are balanced in the same plane. This type of axle is not stressed by the effect of the "whip" at high speeds, and there is likewise no gyroscopic effect by balancing different weights in the same plane.

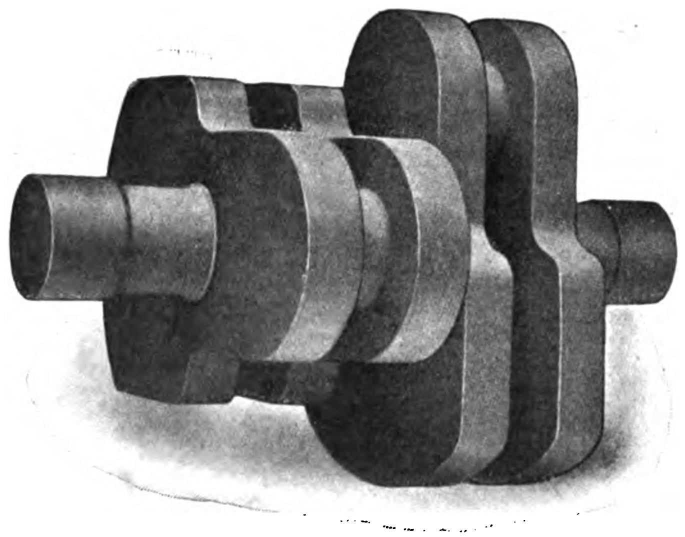


Fig. 8.—Built-up Axle, Weights Balanced in Same Plane.

In a letter signed by Mr. C. M. Taylor, mechanical superintendent of the Atchison T. and S. Fe R., it is recorded that one of these engines hauled a train weighing 562 tons behind the

tender over a length of 202·4 miles, rising 1,565ft., with only one stop (of 14mins.) at Syracuse, in 4h. 12mins. The actual average speed was 48·1 miles per hour; the consumption of coal 8½ tons and of water 14,600 galls.

2—6—2, or "Prairie" Type Express Engine; Lake Shore and Michigan Southern R.R.

One of the Heaviest Passenger Locomotives in the World.

Whilst it cannot by any means be said that engineers in Europe are accustomed to look to America for every improvement in locomotive construction, it is certain that in that country proportions have been advanced to an extent unknown elsewhere. In recent years there have been several instances of the "largest" and "heaviest" locomotives, both passenger and goods, being put into service on United States railways, and quite lately the American engineering papers have questioned the advisability of employing locomotives of such extreme size and power, not so much on the score of the ability of the tracks to support the additional strains thrown upon them as upon the ground as to whether such enormous engines can be operated, under the varying conditions of traffic, with due regard to economy.

The loading gauge in America permits of locomotives being built having a height from rail to top of chimney of close upon, if not actually, 16ft., as compared with a maximum of 13ft. 6in. in this country, and about 14ft. 6in. upon the Continent, whilst a corresponding gain in width so that larger boilers and cylinders and increased dimensions throughout are rendered possible, with a consequent development in the weight and power of the locomotive.

The accompanying illustrations show one of several 2—6—2 or "Prairie" type express passenger locomotives built at the Brooks Works of the American Locomotive Company for the Lake Shore and Michigan Southern RR. The engines of this class were, until quite recently, the heaviest ever built for passenger service, and are remarkable not only for that reason, but also on account of their large adhesion weight, the wheel arrangement and other features to which we refer in detail in the description which follows. These locomotives, which are known on the L.S. and M.S.RR. as class K, followed upon the J series. They have the same wheel arrangement and general design, but smaller proportions in many important respects, with a corresponding reduction in weight and power.

Among other duties required of the new engines is that of hauling, without assistance from piloting, the Lake Shore, Limited, a train usually made up of 13 heavy vestibule cars weighing in the aggregate 743 tons behind the tender, a distance of 183 miles in 4 hours 10 minutes with two stops, the scheduled speed being 44 miles per hour, including stops. On some occasions the weight of the train is increased to close upon 800 tons by the addition of further cars, but the running time remains as usual, in spite of the fact that four stops in place of two are sometimes made.

The cylinders are outside the frames and the connecting rods work on to crank pins in the intermediate pair of coupled wheels. The three coupled axles are all ahead of the firebox, advantageously placed for distributing weight upon them for adhesion purposes. The front end of the engine is carried upon a two-wheeled pony truck, which latter has 8in. of lateral motion, whilst the trailing end is supported upon a two-wheeled truck of the improved "Player" type with 9ins. of lateral motion.

The frames are of the bar type, commonly used in American practice, except at the rear, where they are of the plate form customary in European locomotives. They are of cast steel throughout, the bar sections being 6ins. wide for the greater part of their length. They are strongly braced by means of cast steel cross stays at the rear of the leading coupled axle, by large flat steel castings on top of the frames between the driving and rear coupled wheels and at the point where the bar and plate sections are spliced together just in front of the firebox.

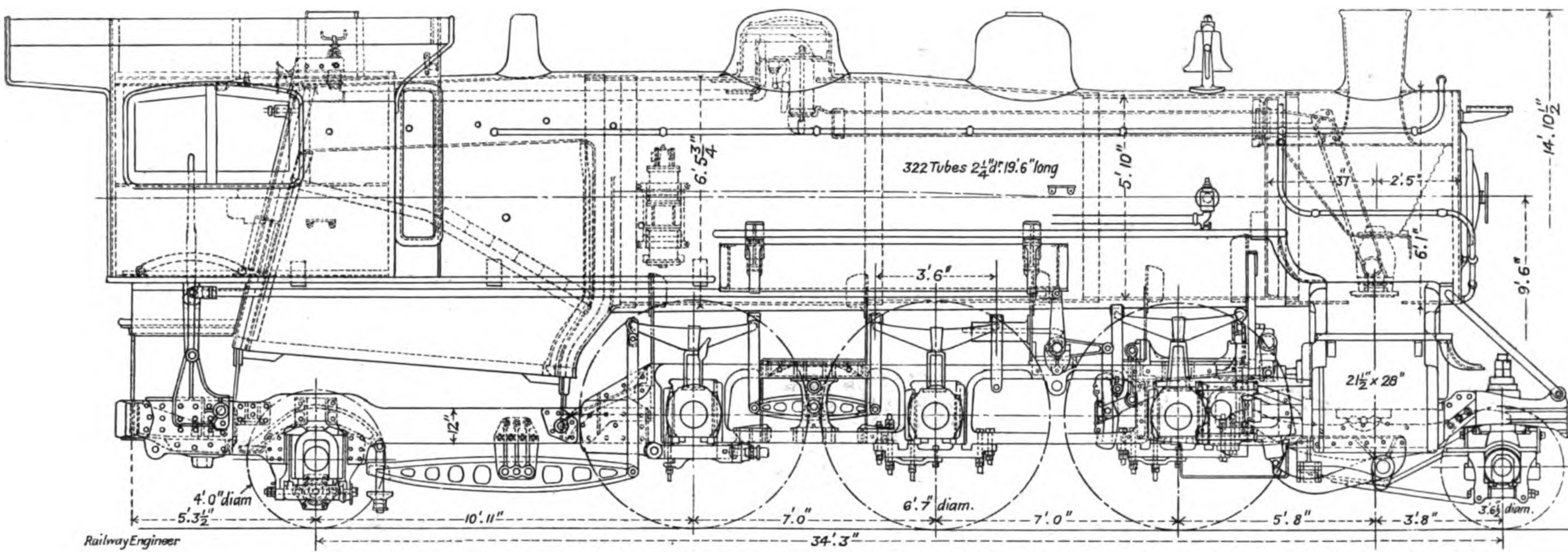
The boiler is of very large size. It is of the "coned" or extended wagon top pattern. The barrel is in three rings, that next to the smoke-box ring being tapered. The plates are of steel, ranging from $\frac{9}{16}$ in. to $\frac{11}{16}$ in. thick. There are 322 tubes of 2¼ins. diameter; the length over the tube plates is 19ft. 6ins. The firebox is of the wide type, with sloping crown plate and outer shell, the construction is of steel throughout with a plate thickness of ⅜in., except for the tube plate, which is ½in. thick. A water space of 4½ins. is provided at the sides and front and 4ins. at the back. Radial stays are used, and the ash pan is of the hopper type with rocking grate. There are two rectangular fire doors hinged to open out back to back, and the brick arch is supported upon four 3ins. water tubes. The smoke-box is extended and is fitted with diaphragms, having netting 2ins. by 2ins. mesh placed at an angle front and back of the blast nozzle.

The springs of the second and third pairs of coupled wheels are connected by equalising beams with those of the trailing truck, and the large equalising beam under the firebox is designed so that the lower or tension member is larger than the upper or compression member, for the purpose of reducing the stresses per sq. in. in tension as much as possible.

The steam chests are located above the cylinders and the piston valves which are 12ins. in dia., are actuated by ordinary link motion with a rocking shaft and specially curved valve rod for transferring motion to the higher plane of the valves.

The principal dimensions of these interesting locomotives are as follows:—

Cylinders, 21½in. dia. by 28in. stroke.
Coupled wheels, 6ft. 7ins. dia.
Front truck wheels, 3ft. 6¼in. dia.
Rear ,, ,, 4ft. 0in. dia.
Coupled wheel base, 14ft.
Total ,, ,, 34ft. 3in.
Piston valves, 12in. dia.
Greatest travel, 5½in.
Outside lap, 1¼in.
Inside clearance, ⅛in.
Lead in full gear, $\frac{1}{16}$ in.
Boiler dia. at front ring (outs), 5ft. 10in.
Height of centre above rail, 9ft. 6in.
Length over tube plates, 19ft. 6in.
Heating surface tubes, 3.678 sq. ft.
,, ,, firebox, 198 sq. ft.
,, ,, water tubes in firebox, 29 sq. ft.
,, ,, total, 3.905 sq. ft.
Grate area, 55 sq. ft.
Working steam pressure, 200 lbs. per sq. in.
Adhesion weight, 74 tons 2¼ cwt.



2—6—2, or "Prairie" Type Express Engine, Lake Shore and Michigan Southern RR.

Weight of engine loaded, without tender, 104 tons 1¼ cwts.

The tender is carried upon two four-wheeled bogie trucks, with outside frames provided with nests of coil springs in the centre portion. The coal capacity is 15 tons and water capacity 7,800 U.S. gallons.

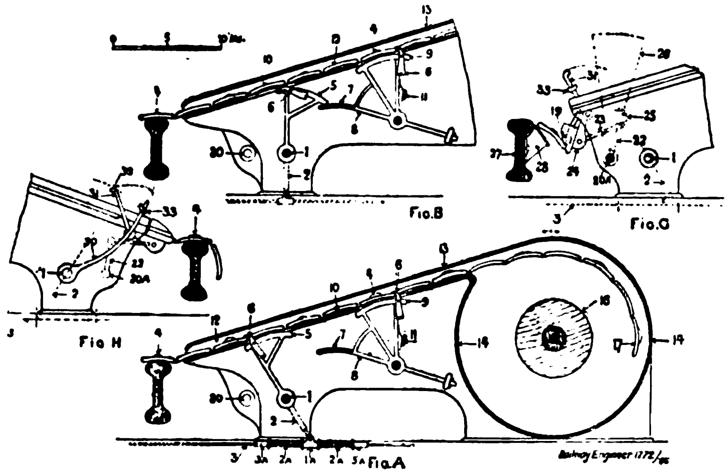
The total wheel base is 18ft., making the total for engine and tender combined 52ft. 3in. The tractive power exerted by the engine is 27,850 lbs.

Recent Patents relating to Railways.

THESE abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d.* each.

Fog Signalling Apparatus. *1,772. 30th January, 1905. A. C. Lee, 65 and 67, High Street, Slough, Bucks.*

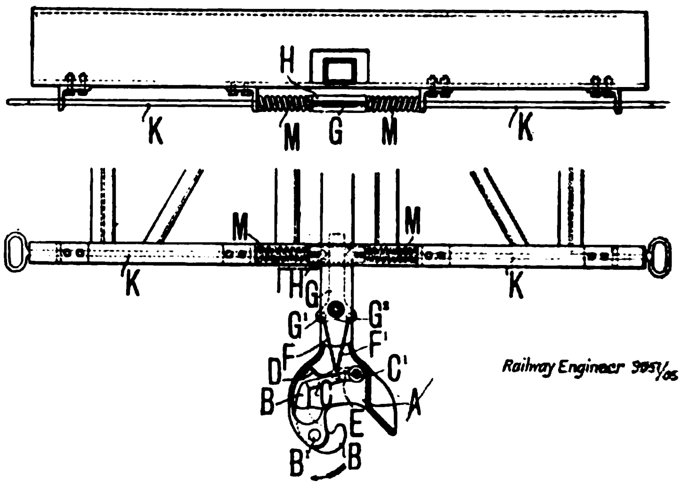
This invention provides an apparatus for placing detonators on the rail and removing them. A linked band carrying detonators alternating with blanks is unwound from a reel and traversed over an inclined guide placed at right angles to the rail. Below the band, levers 2, 8 are mounted, the lever 2 being directly operated by the usual connections 3, between the ordinary signal arm and signal cabin. A hook 6 on the upper end of the lever 2 engages and feeds forwards the detonators, when the signal is pulled to "danger," whilst the lever 8 is operated to place a



blank on the rail as the signal is pulled to "line clear" by the arm 5 on lever 2 bearing on an arm 7 on the lever 8. At the next forward swing of the lever 2 the lever 8 is pulled back by a spring. An apparatus for placing a second detonator on the rail but withdrawing it should the first explode comprises a guide for the band carrying the detonators, the extremity 19 of which is hinged or pivoted so that it can drop below the level of the rail. It is held up by a movable arm or link 23 and spring 25 mounted on a lever arm 22 fixed on a shaft 20A. A fan 26 is also fixed on the shaft 20A, in close proximity to the first detonator, so as to be displaced by its explosion, thereby rotating the shaft 20A and causing the part 12 to fall and pull the detonator off the rail. The detonator is afterwards replaced on the rail by levers 30, 31, which raise the part 19. (*Accepted 11th May, 1905.*)

Releasing Automatic Couplings. *9,051. 29th April, 1905. F. Krupp, Essen, Germany.*

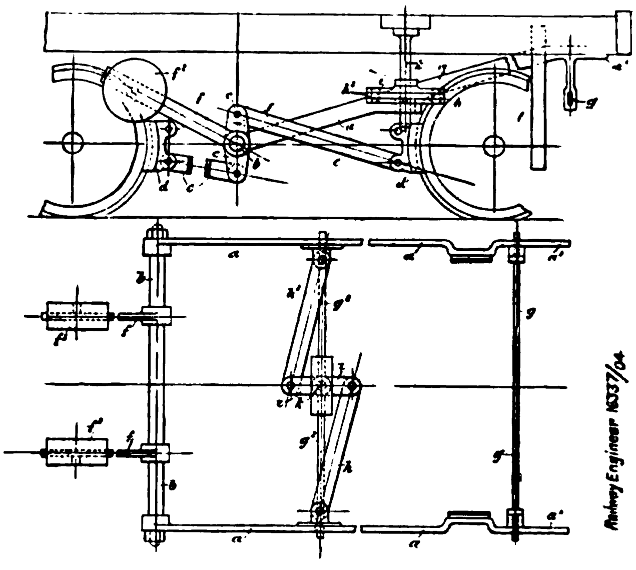
The jaw B of the coupling, which tends to open under the influence of a spring acting on the lower end of the pivot bolt B^1, is locked by a finger C and held in the locking position by a spring D. An arm E is fixed on the lower end of the pivot bolt C^1 of the locking finger, and connected by chains F, F^1 with two arms, G^1, G^2, of a three-armed lever, whose other arm G passes through



an aperture in a tappet H, connected to two pull rods K. Springs M bear against each end of the tappet and normally hold it in the central position. (*Accepted 1st June, 1905.*)

Brakes (Wagon). *16,337. 23rd July, 1904. H. S. Thomas, Kazarma, Llanelly, Carmarthen; and E. Ridley, Arcade Chambers, Llanelly.*

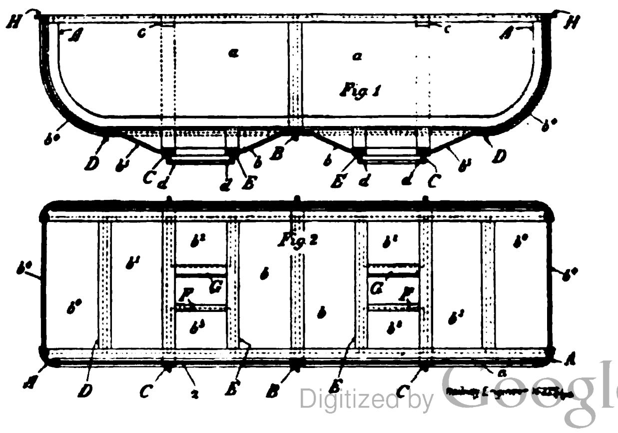
The brake hand levers are counterbalanced by the weights f^2, and are capable of being operated simultaneously from either side



of the vehicle, being connected by rods g, g^2 mounted loosely in slots in the levers, and rods h, h^2 connected to an intermediate crank i. In order that the crank or two-armed lever i may rise and fall with the brake levers it is mounted to slide on a fixed vertical pivot k. (*Accepted 25th May, 1905*).

Wagons. *16,225. 22nd July, 1904. E. Hancox, 8, Dixon Street, Stockton-on-Tees.*

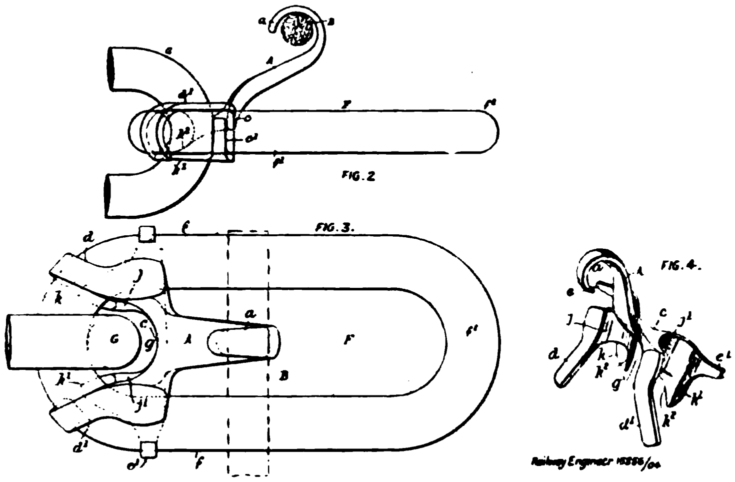
Relates to the construction of wagon bodies which are built up of



sections of metal plates or sheets. Metal bars A, provided with grooves at right angles, are used in conjunction with grooved sections B, D, C, E to form a framing into which metal plates, b, b^1 . . . b^4, with thickened edges, are inserted. When the plates are in place the sides of the grooves are compressed around the thickened parts of the plates forming a strong joint. (*Accepted 25th May, 1905*).

Couplings (Wagon). *15,856. 16th July, 1904. E. J. Hill, 11, Victoria Street, Westminster.*

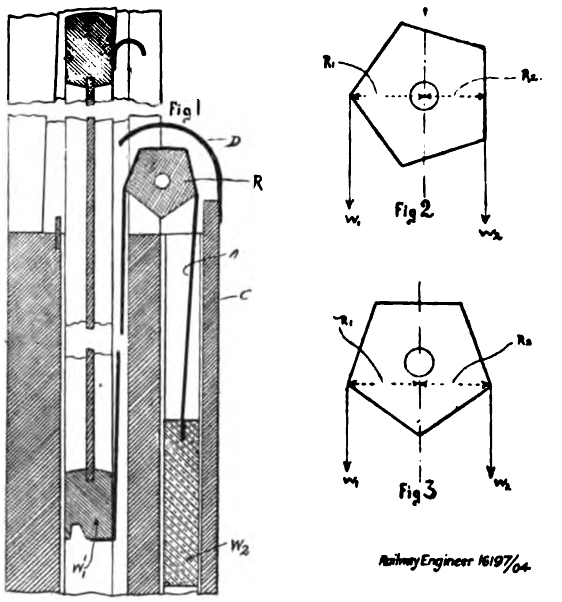
The end link of a coupling chain is provided with a hook or tongue A, adapted to be engaged by the end of a plain pole or



rod to enable the link to be raised and dropped over the coupling hook. Arms d d^1 e e^1 on the hook enable it to be firmly clamped upon the inner bow of the end link. (*Accepted 18th May, 1905*).

Carriage Windows. *16,197. 21st July, 1904. C. Scott-Snell, 53, Victoria Street, Westminster, S.W.*

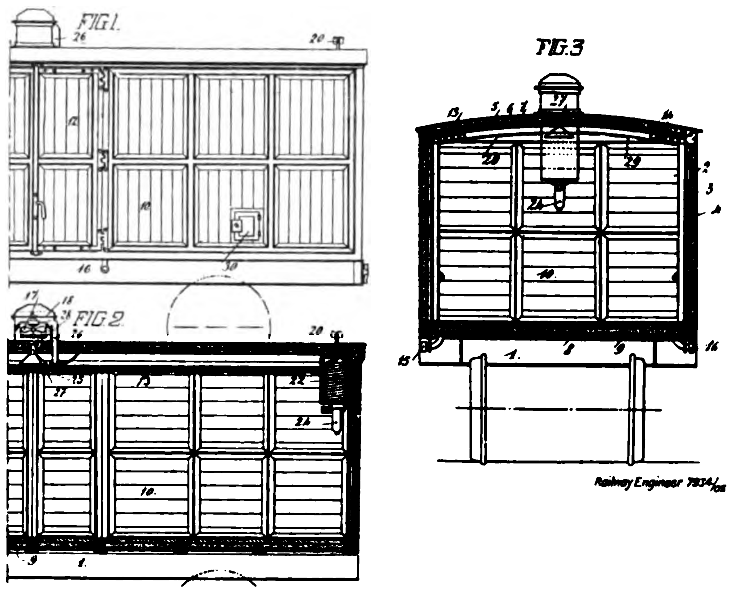
A sliding sash of the usual form is connected by a strap of webbing, passing over a roller R, with a counter-balance weight. The roller and balance weight are so arranged that vibration does not affect the equilibrium, yet a steady force applied by hand is



sufficient to raise or lower the window. To this end the roller is made of triangular or pentagonal section, so that in the course of rotation the weight and the window acting on opposite sides of the roller axis are alternately acting at different radii. (*Accepted 25th May, 1905*).

Refrigerator Wagon. *7,934. 13th April, 1905. The Intercontinental Railway Co., Ltd., 64, Rue Canmartin, Paris, and 110, Cannon Street, London.*

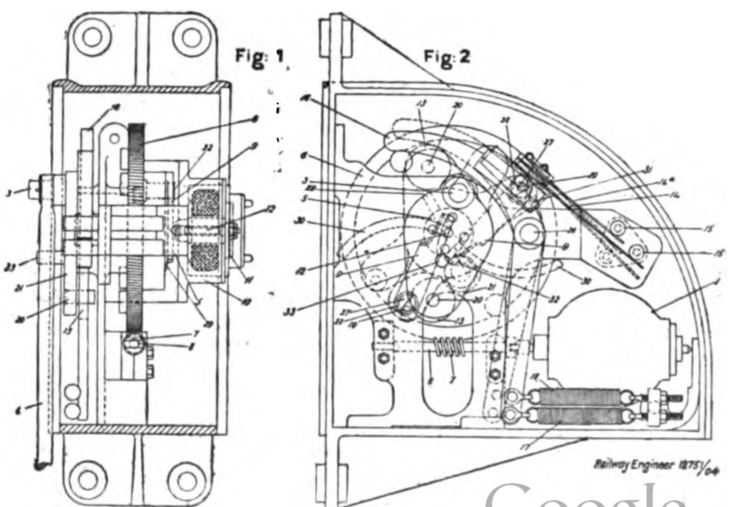
The sides, end and roof of the wagon are provided with triple



walls, whilst the floor consists of a double wall. Insulating materials, such as wood pulp, paper pulp, cellulose or cork, are interposed between the outer wall and intermediate wall. Repairs are facilitated by forming the walls of removable panels 10, this arrangement, moreover, limiting distortions. The maintainence of a low temperature in the wagon is ensured by filling the pipes 13, 14 with an uncongealable liquid. A fan 17 sucks air in through the pipes 20, refrigerating worms 22 and a plug of filtering material. The central air inlet 27 is closed by means of a balanced valve when the fan is not in action. (*Accepted 1st June, 1905.*)

Signals. *12,751. 6th June, 1904. W. R. Sykes, Cedar Lea, Park Hill, Bickley, Kent.*

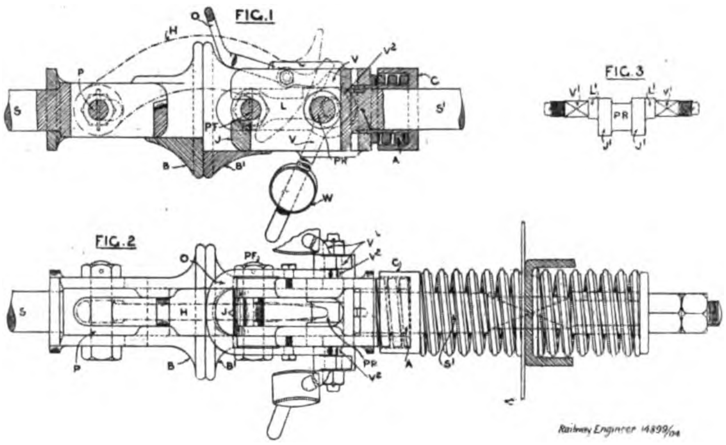
The invention relates to combined electrical and mechanical means for controlling semaphore or other signals operated by electro or other motors. The signal rod is jointed to the crank pin 3 of a shaft 5 on which is a loose spur wheel 6 operated by an electro motor 1 by means of the shaft 8 and the worm 7. The shaft 5 carries a crank piece on either side of the spur wheel the crank pin 3 being on the crank piece on one side and a tripping lever on the crank piece on the other. On one side of this spur wheel are two fixed studs 19, On the crank 28 carried by the crank shaft 5 and forming part of the tripping lever 9 is a small loose shaft or stud 22, which is fitted through the crank piece and forms the fulcrum for the tripping lever 9 and the stud 22 has a semi-circular projection 27. A projection 29 and a quadrant piece 30 form guides for the tripping lever 9. An electro magnet fixed in the box 10 has a circular armature 11, to which is fixed a pin 12. This circular armature in its normal position is held away from the electro magnet by springs. When a current is



sent through the electro magnet the armature 11 causes the pin 12 to form an obstruction in the path of the tripping lever 9. A cam roller 13 is fixed on the pin 20 of the arm 21 and which is fixed to the shaft 5. On an arm 16 are fixed springs 14 and 14^a electrically connected together but insulated from the frame work of the device for the purpose of joining up or cutting off the current from the electric motor 1. The arm 16 has a tail piece and the arm together with its trial piece is pivotted at 26 and operated. Helical springs 17, 18, fixed to the tail piece of the arm 16 serve to keep the arm in its normal position thereby forming contact between the contact stud 15 and 15^a and also forms a brake on the rotating parts when the cam roller 13 strikes the arm 16. When the signal is operated the motor rotates, the electro magnet holds the tripping lever in position, and the crank shaft pulls off the signal, whereupon the current is cut off by the cam operating the contact breaker. When the signal lever is put back the current to the electro magnet is also cut off and the tripping device being no longer held by the pin 12, leaves the crank shaft free, allowing the signal rod and arm to return to its normal position by gravity. (*Accepted 25th, 1905.*)

Couplings (Automatic). *14,899. 2nd July, 1904. J. A. Timmis, 2, Great George Street, Westminster, S.W.*

The object is to provide an elastic and flexible coupling of the central hook type. One half of the coupler consists of a buffer head B which slides on a spindle S provided with springs, against which the buffer head bears. A pin P mounted in slots in the spindle carries a hook H. The other half of the coupler consists of a buffer head B^1 mounted to slide on the outside of jaws J, formed on the end of the spindle S^1 provided with buffer and draw springs. A small auxiliary spring H is placed in a cup between the head B^1 and buffer spring. Pins P F and P R pass



through links L in the head B^1, the pins P R also passing through weighted hand levers V. The rear pin P R is shown more clearly in fig. 3, the two links L L fit on the parts marked L^1 L^1, while eccentrics J^1 J^1 fit into holes in the jaws J J. On buffer head B^1 and hinged on it is the bridle O going over the hook H. The ends of this bridle can turn downwards as the coupler is shown, but if the buffer heads are pressed hard together the ends of the bridle are prevented from falling by the top ends of the hand levers V V. If the levers V V are raised pin P R will revolve on and about the eccentrics J^1 J^1 in the jaw J which serves as a fulcrum, and as a consequence the links L L and forward pin P F are thrown forward, and the hook H can be uncoupled off pin P F. The bridle O prevents the hook H from rising when a vehicle is driven against another. As V V are raised to enable a pair of couplers to be uncoupled the eccentrics cause the small spring A to compress so that there is no necessity to compress the much stronger buffer spring. (*Accepted, 18th May, 1905.*)

SPECIFICATIONS PUBLISHED.

A.D. 1904.

8421. Crossing permit and like apparatus. Higley.
12751. Signals. Sykes.
13128. Buffers. Rees and Moreton.
13163. Crossings and points for tramways and railways. Le Rossignol.
13353. Electrically propelled railway and tramway vehicles. Collins.
13705. Life guards for tramcars. Case and Hampson.
13729. Points for railways and tramways. Zylberlast.
13788. Signalling apparatus. Smith and Newell.
14457. Automatic oil-saving appliance for railway hand lamps. Wood.
14899. Couplings. Timmis.
14990. Manufacture of crossings, points and guard rails. Hadfield.
15856. Wagon couplings. Hill.
16135. Coupling devices. Gray.
16181. Carriage door looks. Bayes.
16197. Carriage windows. Scott-Snell.
16225. Wagons. Hancox.
16337. Wagon brake. Thomas and Ridley.
16390. Fluid pressure brakes. Westinghouse Brake Co.
16586. Point mechanism for electric tramways. Lawrence.
20941. Signalling systems. Prokov and Richter.
21227. Portable apparatus for dressing the surface of rails *in situ*. Woods and Gilbert.
23869. Hopper wagons. Keith and Bonn.
28890. Rail supports. Lovell.
28922. Protecting device for tramcars. Esemann.
29471. Interlocking of points or signals by means of keys. Mackenzie (Hepper).

A.D. 1905.

63. Double volute springs for wagon buffers and draw springs. Mitchell.
1772. Detonator apparatus. Lee.
2447. Life guards for railway vehicles. Watson.
2763. Carriage door locks. Appleby.
5387. Fog or danger signalling apparatus. Blakemore.
7479. Tramway cars. Michel.
7934. Refrigerator wagons. Inter-continental Railway Co.
8933. Mail and package delivering and receiving devices for trains. Le Febvre.
9051. Apparatus for releasing automatic couplings. Fried-Krupp Akt.-Ges.
9666. Wagon couplings. Shingler.
10014. Couplings (automatic). Fried-Krupp Akt.-Ges.

Official Reports on Recent Accidents.

Near **Manors Station, Newcastle, N.E.R.,** *on the 18th March. Lt.-Col. E. Druitt, R.E., reports that:—*

Fireman Allen was found lying dead in the six-foot way between the up north and down Tynemouth lines, close to Argyle Street signal-box, a short distance on the Tynemouth side of Manors Station. He had evidently been run over.

Near Argyle Street signal-box there are four passenger lines running approximately east and west—viz., the up and down north lines and the up and down Tynemouth lines, the latter being on the south side of the former. On both the north and south side of these four passenger lines are sidings, known as the Trafalgar North and Trafalgar South Yards. Between these two yards, crossing the four passenger lines, is a through road with the usual trailing connections to the passenger lines, and a good deal of shunting is carried on at the place. The four passenger lines and the connections between them are fitted for electric traction, but the sidings are not so fitted. The live rails are all protected throughout the length of the sidings by a wooden guard on each side of the rail extending to a height of about two inches above it, but at the connections this protection can only be given on one side of the live rail, as otherwise it would prevent the shoe of the electric car passing from the live rail of the crossing to that of the passenger line.

It is impossible to say exactly how this fatal accident occurred, as no one apparently saw Allen from the time he was relieved from duty at 4.30 a.m. until his dead body was found at 5.45 a.m. When relieved his engine was standing at the western end of the south siding close to the tunnel under New Bridge Street; and he got down from the engine and walked straight back along this siding, towards Manors Station, and he was found about 220 yards away from where he was relieved lying in the six-foot space between the up north and down Tynemouth lines just where the through connection between the north and south yard crosses those lines.

Apparently Allen had been run down by a train on the down Tynemouth line which had dragged his body along for some 24 yards, and, judging from the condition of his clothes, he had apparently been struck from behind. The usual way for men to leave the south yard during the night, when the exits from that side of the line are locked, is to cross by the through connection to the north yard where there is an

entrance always unlocked, and apparently Allen was going this way when run down. It was a wet and stormy morning.

With regard to men crossing from the south to the north yard while it is dark, the through road, being quite straight and free from any "live rails," is safe as far as coming in contact with such rails is concerned, but from a general point of view is not so safe as if men walked along the sidings to Manors Station, where there is a recognised crossing from the siding to the platform, and the men might be encouraged to use this crossing at all times.

*

At **Alexandra Palace Station, G.N.R.,** *on the 11th March. Lt.-Col. E. Druitt, R.E., reports that:—*

The 8.3 p.m. down passenger train from Victoria due at Alexandra Palace at 9.14 p.m. came into collision with the 9.20 p.m. up passenger train which was standing at the western platform.

Three passengers and 3 servants were injured.

The down train consisted of a four-wheels-coupled tank engine running chimney first, with a trailing bogie, and of twelve four-wheeled close-buffered vehicles, fitted with the automatic vacuum brake working blocks on the four coupled wheels of the engine and on all the wheels of the carriages. The brakes were stated to have been in good order.

Two trains were standing in the western platform road, the engine of the first being about 10 yards inside the platform signals, which were at danger, when the down train was allowed to enter the south end of the same platform road.

Under these conditions great care should have been exercised by the signalman working the traffic into the station, but he neglected to give any warning to the driver of the incoming train, who, thinking he had a clear road as far as the middle of the platform, did not observe the platform signals for himself, and, not being warned by his fireman, ran past these signals at danger, and came into sharp collision with the engine of the train which was shortly to leave the same platform.

There is a discrepancy in the evidence as to when the Alexandra Palace home signal was lowered for the incoming train. Driver Shadwell and his fireman, Jarman, both declare it was already lowered before their train left Muswell Hill Station, 340 yards from the signal-box, and that they saw no signal given from the signal-box on passing it, whereas signalman Stratford says he did not lower the home signal until he thought the engine was almost up to it. On the other hand, signalman Talbot, at Muswell Hill, says he saw the signal light change from red to green when the tail of the train was about leaving the north end of that station platform, which would be when the engine was 130 yards away from the Alexandra Palace home signals. From this it is evident that signalman Stratford failed to carry out the rule as regards stopping a train at the home signal before cautioning the driver as to a train being already at the platform. He admits he never carried out Rule 87 (*b*), which requires a train to be stopped at the signal-box and the driver verbally warned to proceed cautiously, but says he tried to exhibit a green light, but owing to the rain the window stuck, and he could not open it.

Although the collision was mainly due to the neglect of signalman Stratford to warn the driver of the incoming train, yet both he and his fireman failed to observe the platform stop signals, and ran past them at danger at considerable speed. It is true they are difficult to see from the right-hand side of the engine, but a driver can easily cross the foot-plate and look for himself, so driver Shadwell cannot be acquitted of all share of responsibility for the collision, even if fireman Jarman, who was looking out, did not tell him that the signals were at danger. It is difficult to understand how fireman Jarman failed to see these signals, as they are very plainly visible, if he were on the look-out. The speed when entering the station appears from the force of the collision and the damage done to have been too high for a terminal station, and for this the driver must be held responsible.

At **High Street Junction, Gateshead, N.E.R.** *On 3rd April. Lt.-Col. E. Druitt, R.E., reports that:—*

The carriage next the engine of the 7.55 p.m. York to Newcastle passenger train left the rails and was partially overturned. Two passengers complained of shock. The train consisted of a 4-coupled bogie engine, tender, and 8 coaches fitted with the Westinghouse automatic brake.

Approaching Gateshead East Station from the direction of Sunderland the line forms a sharp reverse curve. For down trains this commences about 100 yards before reaching Hawks Junction signal-box, where the curve is to the left, the radius being 10 chains for a distance of about 280 yards, then there is a straight portion of 120 yards, and then a sharp curve to the right of 6 chains radius at High Street Junction, increasing to 9 chains radius through the station. At High Street Junction there are facing points in the down road leading to a goods line, but the passenger line has a curve of 6 chains radius as above mentioned. The first marks of derailment were on the check rail of the inner running rail just 50ft. beyond the facing points, and 5ft. in front of the point of the crossing; all three right hand wheels of the vehicle had evidently mounted the check rail, and then went off to the left of the line, and the left hand footboards mounted the down platform and scraped along its outer edge. The train came to a stand at a distance of 258 yards from the point of derailment. There is a speed restriction of 10 miles an hour round both the curves mentioned above.

This derailment was due to the excessive speed at which driver Halford drove the train in question round the sharp curve at High Street Junction, and also to the fact that he applied the brakes hard on just as he approached the junction.

The vehicle derailed had 6 wheels with a wheel base of 23ft. and lateral play of 2ins. in the middle axle boxes. With the brakes suddenly applied the weight of the rest of the train would press this leading carriage against the heavy engine and tend to lift it, and this, with the speed, would facilitate the wheels mounting the check rail against which they would be grinding heavily on the sharp curve.

An engine had been derailed at the same spot two days previously, and a new check rail had been put in on the afternoon of the day of the derailment of the vehicle in question, and the curve had then been examined by the inspector of the district.

The Co. has already taken steps to widen the line at this spot, so as to enable a curve of larger radius to be laid in at the junction, which it is most desirable should be done, and any tendency on the part of drivers to exceed the authorised speed at these curves should be carefully checked.

*

At **Devonport Station, G.W.R.** *On 28th February. Lt.-Col. H. A. Yorke, R.E., reports that:—*

The 7.10 passenger train *ex* Falmouth collided with a goods train. The driver and the fireman of the goods engine and 1 passenger were injured.

This collision was due to the failure of the driver, H. Hammacott, to have the Falmouth train under proper control when approaching Devonport. There are two up distant signals for Devonport Station, the outer 750 yards and the inner 206 yards from the home signal. The inner distant signal is worked by the same lever as the home signal, and is merely a repeater of the latter. Such a signal is unusual, and is necessary because a tunnel about 120 yards long on the west side of Devonport Station shuts out the view of the home signal.

The goods train was being shunted on to the down line in order to make way for the up passenger train. It is usual to shunt the train from the up to the down line by means of the cross-over road at the east end of the station, but owing to the presence of a ballast train on the down line it was not possible to use this cross-over road, and signalman May therefore decided to shunt it through the cross-over road at the west end of the station, which is only a few yards in advance of the up home signal. Before he decided to do so he had been asked from

Keyham "Is line clear?" for the passenger train, and as the goods train was waiting to be shunted at Devonport he accepted the passenger train under the warning arrangement ("Section clear but station blocked"). This was at 9.49, and immediately after this he received the "Train entering section" signal from Keyham. In spite, however, of the fact that the passenger train was approaching Devonport from Keyham, May allowed the goods train to shunt across from the up to the down line, the home signal covering the operation being, as stated, only 12 yards from the fouling point of the cross-over road from the up main line. The instructions on the block signalling card in Devonport signal-box authorise the use of the "warning" signal for passenger trains, and places no restriction as to the conditions under which it is to be used. Signalman May was therefore, according to the strict interpretation of the Rules, entitled to shunt the goods train in the face of an approaching passenger train. He admitted that if he had seen the passenger train approach he would have brought it to a stand before allowing the goods train to move, but thought there was time for the goods train to clear the up line before the passenger train would arrive. As, however, there is a tunnel immediately west of Devonport Station, it was clearly impossible for him to see the passenger train, and as he had no knowledge as to how near the passenger train might be he committed an error of judgment in not waiting until this train arrived before he shunted the goods train.

Driver Hammacott probably expected when he emerged from the tunnel to find that the home signal had been lowered to admit him to the platform, and that he never anticipated being stopped at the home signal. He had no right to act upon any such anticipation. He had been on duty about 7 hours.

Signalman Maynard at Keyham ought to have stopped the train at his up home signal and then allowed it to draw slowly down to the starting signal, and he could then have "warned" the driver by word of mouth as the train passed the signal-box. Driver Hammacott did not receive a proper "warning" on passing Keyham.

The Company should be invited to take the necessary steps to prevent the "Section clear but station blocked" signal being used at Devonport in the manner and for the purpose described in signalman May's evidence. The use of this signal is always attended by some risk, for not only is the signal one that may easily be misunderstood, but there is a chance of its being abused. In this case it seems to me that both these conditions arose; it was not understood by driver Hammacott, and it was used by signalman May for a purpose which involved unnecessary risk.

It may be that the signal cannot be dispensed with altogether (though if drivers could invariably be relied on to obey the semaphore signals it would not be required), but its use should be as limited as possible and only authorised for special reasons.

*

At **Saltash Station, G.W.R.** *On 27th March. Major J. W. Pringle, R.E., reports that:—*

The engine, fitted with a steam brake, set back with violence on to 6 coaches, forming the 6.15 a.m. workmen's train from Saltash to Devonport, then standing at the down platform in Saltash Station. Twenty-seven passengers complained of injuries.

The driver and fireman state that the engine attained a speed of from five to eight miles an hour before steam was shut off, and that the latter applied the hand brake, which, owing to the slipperiness of the rails, had very little effect. At a distance of 10 to 15 yards from the coaches, which were held by the vacuum brake, the driver appears to have suddenly applied his steam brake, with the result that the engine wheels skidded and the collision occurred.

Acting-driver Lander and fireman Williams are responsible for the collision, which was probably brought about by some lack of caution on their part. This may possibly have been induced by their anxiety to start as soon as possible, on account of the train being so late, and the desirability of making up time so that the workmen might reach the dockyards at the hour fixed.

*

At **Craiginches, C.R.** *On 16th January. Lt.-Col. H. A. Yorke, R.E., reports that:—*

The 5.30 p.m. (Aberdeen to Kinnaber Junction) North British passenger train was run into in rear by the 5.40 p.m. (Aberdeen to Perth) Caledonian passenger train. The guard of the N.B. train and 5 passengers were injured.

The N.B. train consisted of 2 engines and tenders and 10 vehicles, and the Caledonian train an engine and tender and 9 vehicles, and an assistant engine in rear. The three last vehicles of the North British train were badly damaged. Both trains were fitted throughout with the Westinghouse continuous brake. The N.B. train was standing with brakes "off."

Craiginches is merely a block post. The up-home signal is 200 yards from the signal-box in the direction of Aberdeen. The up-starting signal is 120 yards and the up-advanced starting signal 590 yards south of the box. Immediately south of the signal-box there is an over-bridge carrying a roadway over the railway, which hampers the view of the line from the box. The night was a very wild one, there being a high wind and heavy rain.

The collision was due to the mistake made by signalman James Cowie at Craiginches, who, having stopped the North British train at his advanced starting signal at 5.37 p.m., forgot to lower the signal for it, and accepted the 5.40 Caledonian train ex Aberdeen from Ferryhill Junction at 5.44, while the North British train was still standing at the above signal. The reason the North British train was stopped at the advanced starting signal was because when it first arrived, the section between Craiginches and Cove was not clear, being occupied by a previous train.

Cowie's mistake was probably due in the first instance to a lapse of memory, but after he had enquired from Cove as to whether the North British train had arrived, and had received an answer in the negative, he was certainly remiss in not looking out of his window to see whether the train was still at his advanced signal or not. Had he taken this simple precaution he would have realised his mistake, and the accident would not have occurred. He had been on duty 5¾ hours.

Guard Hardy, who was riding in the last van of the 5.30 North British train, should, according to the rule, have gone back to the signal-box to remind the signalman of the presence of his train when he found that it was being unduly detained. The rule leaves it to the discretion of the guard to decide for himself after what length of detention it is his duty to go to the signal-box. In this case Hardy's discretion was at fault. He had been on duty about 8¾ hours, including 3½ hours' rest in Aberdeen.

A cattle train in the sidings and the curvature of the line prevented the driver of the C.R. train seeing the N.B.R. train until he was about 30 yards from it.

The advanced starting signal at Craiginches is not well placed. It is 590 yards from the signal-box, and the view of it is bad owing to the curvature of the line and the position of the sidings on the inside of the curve. The signal has been recently placed in its present position in consequence of the alterations in the sidings and of the points leading thereto. The reason of it being placed so far out is, to allow a train to get in and out of the sidings while another train is standing on the up main line at the advanced starting signal. The position therefore cannot well be altered, but in order to guard against a repetition of the present accident, the company has decided to place an electric treadle a full train's length ahead of the advanced starting signal to control the home signal in such a way that the latter, having once been lowered for a train, cannot be lowered for a second train until the previous train has passed over the treadle in advance of the signal.

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THE
Railway Engineer

VOLUME XXVI., No. 308. *SEPTEMBER*, 1905.

Contents for September.

Mr. James S. Beale having retired from the firm of Beale and Co, of Birmingham and London, solicitors to the Midland R, has been elected a director of the company in succession to **Sir Henry Wiggin, Bart.**, who has retired on account of his advanced age.

Mr. Thos. M. Wormald, of Dewsbury, has been elected a director of the Great Northern R. to fill the vacancy caused by the resignation of **Sir Savile Crossley.**

Sir George S. Gibb, general manager of the North Eastern R., has accepted the chairmanship of the board of management of the Railway Benevolent Institution for the ensuing year.

Mr. E. Lake, chief assistant goods manager of the North Eastern R., has been appointed general manager of the Barry R. in succession to **Mr. R. Evans**, who has accepted a seat on the Board.

Mr. Edward Watkin, mineral manager of the Great Central R., has been appointed general manager of the Hull, Barnsley and West Riding Junction R.

Mr. F. A. Campion, district engineer at Peterborough, Great Northern R., has been appointed to succeed **Mr. Charles Lavey**, district engineer at King's Cross, and who has retired after 43 years' service.

Mr. H. F. Golding, assistant locomotive engineer at Penarth Docks of the Taff Vale R., has been appointed locomotive engineer of the Barry R. in succession to **Mr. J. H. Hosgood**, who has left the company.

The retirement of **Sir David Hunter, K.C.M.G.**, general manager of the Natal Government Rs., is announced, and the Legislative Council have unanimously agreed that his 26 years of service "call for fitting acknowledgment and special recognition."

Mr. A. C. Carr, one of the district locomotive superintendents of the East Indian R., has been appointed works manager of the Bengal-Nagpur R. at Khargpur, with the rank of assistant chief mechanical engineer.

The sudden death, at Rondebosch, near Cape Town, of **Mr. John Brown, C.M.G.**, late chief engineer of the Cape Government Rs., was announced last month.

We regret to have to record the death of **Mr. W. E. Langdon**, consulting electrical engineer to the Midland R. He was telegraph superintendent of the company from 1878 until the end of 1902, when he was superannuated. He was a member of council of the Institution of Electrical Engineers and President in 1901-02. He died on the 12th ultimo, the day after his 73rd birthday, at Westcliffe-on-Sea.

*

London and North Western Railway.

OUR premier railway, which, according to some amateur critics and "experts," is supposed to be going rapidly down hill, again "dished" the "crokers" by maintaining its dividend of 5 per cent. and carrying forward £74,494, nearly the same amount as in the previous corresponding half-year. The accounts show an increase from coaching traffic of £9,832, notwithstanding a large decrease of 741,000 in the number of passengers carried. The passenger train mileage increased by 240,516 miles, which is largely due to the through express trains from the north to the south coast. There was a small decrease, £9,460, in the receipts from goods traffic. The working expenses, notwithstanding the increase of £18,000 for rates and taxes, were reduced by £35,159. The goods and mineral train mileage was reduced by 257,516 miles, but the receipts from live-stock and minerals were slightly greater, and from merchandise slightly less. Such figures speak for themselves.

*

Rates and Taxes.

LORD STALBRIDGE drew the especial attention of the L. and North Western R. shareholders to the increase of £18,000 during the past half-year under the head of rates and taxes, and stated that 95 per cent. of the increase was due to increased poundage over which, of course, the company had not the slightest control. He further pointed out that out of every £ earned on the ordinary stock 4*s.* 2*d.* is paid in rates and taxes as against 2*s.* 6*d.* ten years ago, and 1*s.* 9*d.* twenty years ago, and these amounts do not include income tax.

*

Railway Subscriptions to the British Cotton Growing Association.

BOTH the L. and North Western and the Lancs. and Yorks. railway companies have subscribed £1,000 to the funds of the British Cotton Growing Association. It is so obviously to the interests of the ordinary shareholders of these companies that Lancashire should have more fields to draw its supplies of raw cotton from than it has at present, that it is rather surprising that the directors should have thought it necessary to bring the vote before the half-yearly meeting, particularly as they pay away large sums annually with the greatest secrecy to the International Railway Congress, which is of very little (if any) benefit to the ordinary shareholders.

*

The Hall Road Accident; Lancs. and Yorks. R.

THE terribly fatal collision that occurred on the 27th July at Hall Road Station on the Liverpool-Southport electrically worked section of the Lancs. and Yorks. R. had several notable features.

It is the first bad accident on an electrically operated railway in this country, but the method of traction had nothing whatever to do with the cause of it.

An express from Liverpool was turned off its line, which was clear, on to a middle road occupied by an exactly similar, but stationary and empty, train. The loss of lives was appalling, viz., 20, and out of all proportion to the number, 3, of the injured. The body of the first car of the express passed into the body of the first car of the standing train. No wheels left the rails and the heavy motor bogies of the leading car of the express drove the motor bogies of the first car of the standing train under the second car. No "shorts" of any moment, and no burning of the wreck occurred. The fuses at the power house were immediately blown and both lines became dead, and the adequacy of the precautions adopted against fire fully demonstrated. The cause of the accident was a very simple one, and under similar circumstances would produce a like disaster at any station in the country. It was a violation by the signalman of what may be called the first law of interlocking. The points had been set for the road on which the empty train was standing, and the signalman *thought* he had put them back for the road the express wanted, and which, being clear, he tried unsuccessfully to pull the signal off for. He then *assumed* the signal was out of order, and flagged the express on with the above-stated result. The signal had previously given trouble, but had worked properly all the day, and was, as a fact, in proper order.

The coroner's jury found that the signalman's mistake was "censurable but not criminal." They also recommended that facing points at Hall Road and everywhere else possible should be abolished. It is, of course, necessary to make some allowance for the over-wrought condition of the brains of coroners' juries on these sad occasions.

In connection with this accident, a statement has been widely circulated in the papers to the effect that the signalmen on the Liverpool-Southport electric line are heavily fined if they stop an express train. So far as we know this statement has not been contradicted, and if such a nefarious practice do exist the sooner it ceases the better, as it would be monstrous that signalmen earning 24*s.* per week should be tempted to take risks with express trains rather than with their own pockets.

*

Metropolitan "Inner Circle" Electric Working.

It seems to be by no means certain that the "Inner Circle" will be worked electrically this month. The M. District were lately reported to be "waiting to hear from the Metropolitan R. When the modifications to their shoes for picking up the current have been made the 'circle' service will commence." We hear that the shoes which are beyond the ends of the bogies are being shifted to the middle of the bogies. On the other hand it is said that a mountain has been made out of a mo'e-hill and that the Metropolitan District are, or were, short of cars, and not very sweet on the circle traffic. The Metropolitan staff evidently devoutly believe in some such theory, for they all have but one stereotyped answer to all enquiries, viz.: "They (meaning the District) are not ready for us yet." Whatever the cause may be the result is not one to be proud of.

*

Electric Traction on the North Eastern Railway.

As to the results obtained from the "electrified" lines of the North Eastern R., the chairman was not very enthusiastic at the half-yearly meeting. He said a year's working was too short a time to judge by. But as compared with the last year of steam working the passengers have gone up 20·9 per cent. and the receipts 17·6 per cent., against which "you have to take into "account the capital which has been spent and allow for deprecia-"tion." The electrification "has resulted in some increase of "net revenue, and therefore it has been a convenience to the "public, because more people travel, and it has been profitable "to the railway because it has brought us increased traffic." We should like to see the comparison made with steam working before the electric tramways had depleted the company's revenue.

*

Electric Traction on the Lancs. and Yorks. Railway.

As the complete electric service on the Liverpool, Southport, and Crossens line has only been in operation six months the Chairman of the L. and Y. R. was not able to tell the shareholders at the half-yearly meeting very much as to the financial results of the electrification. He said it had been quite satisfactory, that 600,000 additional passengers with ordinary tickets had been carried, and that the number of season tickets had increased. The fine service had also induced building operations along the line. He was, however, quite clear that it would be impossible to give such a rapid and frequent service by any other method.

This may be so, and without doubt the service is a smart one. The whole line, with its level crossings and absence of bridges, is, in fact, quite American, but as a railway service it is a long way behind what is done on the Great Eastern R.

Sir George Armytage is further reported to have said that there were indirect advantages to be considered, particularly the reduction of operations necessary at the terminal station, as the train could leave the platform it arrived at without any shunting, and this alone will postpone the necessity for enlarging the Liverpool station for some time.

This is a substantial reason which would have become interesting had the estimated cost of enlarging the station been given. The use of platforms in terminal stations, both for the arrival and departure of the same train without shunting, is, of course, *not* peculiar to electric working, and has been for years the practice with suburban trains at every large terminal station.

*

North-East London Railway Authorised.

The Act authorising the construction of the North-East London R. was passed before Parliament rose. The railway will start from the City near the Monument, and run to Waltham Abbey —a distance of about 14½ miles, the first 4½ miles of which (to Hackney Road) will be in tubes. The line will then rise to the surface and continue in the open. It will be worked by electric power, and will, it is estimated, cost about £4,000,000 to construct. It may be safely said that nearly all the traffic it will carry for some time will be taken off the Great Eastern R.

*

Royal Commission on London Traffic.

The Report of the above-named Commission is to be shortly followed by seven other volumes containing the minutes of evidence, appendices, maps, &c.! The public generally, and the press particularly, are much indebted to Mr. Lynden Macassey, M.A., B.Sc., secretary to the Commission, for preparing and issuing for the convenience of the press a masterly digest of the Report printed on one side of the paper only ready to send to the printers. This digest was, of course, issued quite unofficially, but it accounts for the skill and ability which nearly all the papers have displayed in dealing with the lengthy and complicated Report.

The principal recommendation of the Commission is that a Central Traffic Board, consisting of a chairman and two or four members, should be established, and which should report annually to Parliament on all matters affecting locomotion and transport in "Greater London," examine and as far as possible settle Bills before passing them on with a report to Parliament, determine disputes as to running powers, interchange of traffic, &c., between railways and tramways.

The Commission strongly recommend the consolidation of Tramway and Light Railway Law and the abolition of the "veto" of local authorities and frontagers.

As regards railways the Commission points out that it is of vital importance "not to attempt to use urban railways in any "way or for any purposes which may prevent the running on them "of train services of maximum frequency." It considers that when the railways now under construction are completed all the London main line stations will be provided with adequate facilities for distributing the passengers arriving at them, except in the cases of Paddington and Victoria and Fenchurch Street. To meet the case of Victoria it recommends the extension of the North-West London R. from Marble Arch. It also recommends better connection between the western suburbs and North-East London. It favours shallow tunnels in preference to tubes.

The Report is full of useful information, but its proposals, especially as regards road traffic, are quite Utopian, and utterly impracticable.

Road Motor Services; L. and North Western R.

A MOTOR service between Connahs Quay and Mold, connecting up the main line to Holyhead with the cross-country line from Mold to Denbigh, has been inaugurated by the L. and North Western R. Co. The cars start from Connahs Quay and run alongside the estuary of the Dee as far as Flint. From thence the road leads south over Flint Mountain, from which a very extensive view of the whole estuary of the Dee is obtained, and then on through the picturesque village of Northop to Mold, a distance of 10¾ miles. The same route is taken on the return journey.

The cars seat 34 passengers and carry a limited quantity of luggage.

Since the omnibuses started running they have been very well patronised, and are bringing many people from the country districts to the market at Mold, as well as affording easy access to Northop, which has hitherto been rather isolated, the nearest railway station being three miles away.

So far there has been no failure of any kind. The distance covered is from 18 to 19 miles, or three complete journeys daily.

The company have also put into service, between Holywell station and Holywell Town, a steam goods lorry which was exhibited at the Royal Agricultural Show at Park Royal in June, and propose to shortly run a motor 'bus service similar to the Mold Connahs Quay one above mentioned.

Holywell lies at the top of a very steep hill 1¾ miles from the station, and hitherto the average weight taken by a pair-horse team has only been 13 cwt. The new steam lorry is capable of taking 5 tons, and also a trailer with a capacity of 2 tons.

*

Scottish Railway Notes.

THE financial half-year which has just ended has been a very prosperous one so far as the two leading Scottish railways are concerned—the North British comes out well to the fore with an increase of £19,743, and the Caledonian follows with one of £14,759. On the other hand the Glasgow and S.W. records a decrease of £12,677.

The new naval base at Rosyth on the Forth will be another "plum" for the North British R. Company, which has a monopoly in Fife, and which has now been instructed by the Admiralty to proceed with the construction of the branch line for both passenger and goods traffic with all possible despatch.

The "powers that be" of the Caledonian R. seem to recognise the advantages that are to be derived from extensive advertising, and their new posters are very attractive and artistically got up.

The arrangements in connection with the Royal Review which is to take place in Edinburgh on the 18th inst. is taxing the energies of the officials in the excursion departments to the utmost, and night work is being resorted to.

The competition between the three leading companies or the traffic to and from Glasgow and the Clyde resorts by reducing the time of the journey is to be further promoted by the addition to the North British fleet of another new paddle steamer, which is expected to make greatly-improved "records." No where round Great Britain is there such keen rivalry.

*

United States Metallic Packing.

MANY of our readers will be interested to know that the United States Metallic Packing Co., Ltd., of Bradford, Yorks., have opened a London Office at 17, Victoria Street, Westminster.

*

Large Order for Oil-feeders.

WE understand that the Admiralty have placed an order with Messrs. Joseph Kaye and Sons, Ltd., Leeds, for 4,700 of their new patent serrated oil-feeders.

*

Beira Railway.

WE are informed that an agreement has been arrived at between the Mozambique Co. and the Beira R. Co. with regard to reduced railway rates for goods imported into the Mozambique Co.'s territory and Rhodesia via Beira.

So long ago as September last it was decided that the rates for goods entering via Beira should be reduced, and in the early part of this year the manager of the Beira and Mashonaland R. returned to South Africa to prepare a new tariff, which, after careful consideration and adjustment, has been accepted by the various companies interested.

The new rates, of which notice will be published on receipt of the approval of the Portuguese Government, in so far as they relate to the Mozambique Co.'s territory, are considerably lower than those now in force, the reductions varying according to the class of goods from 10% to 35%. The reductions should largely increase the traffic over the Beira R., and make Beira the principal port of entry for the whole of Rhodesia.

Books, Papers and Pamphlets.

Earth and Rock Excavation. BY CHAS. PRELINI, C.E. London: Crosby Lockwood and Son. 1905.

This is a practical treatise upon the important subject of excavating, removing and depositing rocks and earth. Though in the construction of railways, docks, canals and other public works these operations generally comprise the most important part of the work there appears to be a great dearth of books treating of them; in fact, the author, and we think rightly so, states that he knows of no book in the English language which covers descriptions of the different operations required for planning and executing any excavation work and which classifies and describes clearly the various implements and machines used for excavating and disposing of the spoil. There is, without doubt, a vast amount of information on the subject stored away in the Proceedings of the Institutions of Civil Engineers of England, Ireland and America, but it has to be excavated at a considerable expenditure of time and labour. For this reason alone Mr. Prelini's very able and complete work will be welcomed with avidity by young engineers, for whom the book is primarily intended, and will also speedily find its way on to the book shelves of older engineers and contractors as an excellently arranged work of reference.

The book is conveniently divided into short chapters, the first two being devoted to the graphical representation of earthworks and the methods of calculating quantities and the cost of earth work. The next chapter carefully reviews the question of balancing cuttings and embankments, and the desirability or otherwise of spoil banks and borrow pits.

Excavation of rocks without and with the aid of blasting are dealt with in turn, and the necessary hand and machine tools described and mostly illustrated. Rock-drilling is treated with care and at length, as are also the details of blasting, including the transport and storing of explosives, the firing of the charges, &c.

Excavation of earth is next described. Beginning with a few remarks as to the relative advantages of the long and short handled shovel, the author deals in turn with most of the diggers, excavators and grabbers. In a similar way the removal of material begins with the wheelbarrow and ends with the large Goodwin dump-cars. Several systems of hauling on inclined roads, vertical hoisting and transporting by aerial ways are discussed, and their relative features reviewed.

The latter portion of the book is given to a consideration of the direction of excavation work. The examples chosen are well selected and cannot fail to be useful, as will be the data given as to the shrinkage of earth.

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Books Received.

The World's Locomotives. A digest of the latest locomotive practice in the railway countries of the world. By CHARLES S. LAKE. With 8 folding plates and over 300 photographs and detail drawings. London: Percival

Marshall and Co., 26-29, Poppin's Court, Fleet Street, E.C. [380 pp.; 9½ins. × 6¼ins.; price 10s. 6d. net.]

Universal Directory of Railway Officials, 1905. Eleventh year of publication. London: The Directory Publishing Co., Ltd., 3, Ludgate Circus Buildings, E.C. [667 p.p., price 10s. net.]

Electric Trucks. Record of recent construction. No. 50. Baldwin Locomotive Works, Philadelphia, Pa., U.S.A.

The Law and Practice relating to Patents, Trade Marks and Designs. By DAVID FULTON, Assoc. M.Inst. C.E., Barrister-at-Law. 3rd edition (1905). Jordan and Sons, Ltd., 116 and 120, Chancery Lane, London, W.C. [672 pp.; 8½ins. × 5½ins.; price 12s. 6d. net.]

The "Handy" Hotel Guide. Eleventh edition. Published by the Hotel and General Advertising Co., Ltd., 239, Shaftesbury Avenue, London. [Price 2d.; gives useful information about upwards of 1,000 hotels, mostly in this country.]

Tales of the Rail. By RAILWAY MEN. Published for the benefit of the funds of the Irish Branch of the Railway Benevolent Institution, under whose auspices the book is issued. Second edition, 20th thousand. Dublin: The F. W. Crossley Publishing Co., Ltd., 1905. [96 pp.; 7¼ins. × 4¾ins.; price 6d.]

This is a collection of railway anecdotes which are well worth reading. They are mostly amu ing or interesting, and will serve to while away the time of a journey very pleasantly.

A Guide to Standard Screw Threads and Twist Drills (small sizes). By GEORGE GENTRY. Illustrated. London: Percival Marshall and Co., 26-29, Poppin's Court, Fleet Street, E.C. [The Model Engineer Series, No. 27, 77pp., price 6d. net.]

Modern Engines and Power Generators. A practical work on prime movers and the transmission of power steam, electric, water and hot air. By RANKIN KENNEDY, C.E. With 8 plates and 221 illustrations. Vol. VI. (and last). London: The Caxton Publishing Co., 84-86, Chancery Lane, W.C. [208pp.; 10½in. × 7⅜in.; cloth, price 9s. net.]

"Red Books" of the British Fire Prevention Committee. Edited by the Executive. London: Published at the Offices of the Committee, 1, Waterloo Place, Pall Mall. [Price 2s. 6d. each.]

The Committee Reports on Fire Tests:—

No. 96. *A Floor* by the National Fireproofing Co., Pittsburg, U.S.A., and London.

No. 98. *Two Doors* by the Gilmour Door Co., Ltd., Trenton, Canada, and London.

65 ft. Composite Corridor Carriages; Caledonian Railway.

As stated in our last issue, the Caledonian R. Co. have, with the object of improving their service between Glasgow and Edinburgh and Aberdeen, had constructed at their works at St. Rollox, to the designs of Mr. J. F. McIntosh, M.Inst.C.E., locomotive, carriage and wagon superintendent, some very fine new corridor carriages, of which, by the courtesy of Mr. McIntosh. we were able, on pp. 224-6 of our last issue, to publish the drawings of the bodies. The drawings of the underframe and bogies accompany this article.

Our drawings refer specifically to the composite carriages, but as cross sections and end elevations of the vans were also given they may be taken as illustrating the entire trains. The composite carriages illustrated are divided into eight (five first and three third) compartments, besides the lavatory at each end. For these trains—the Grampian express—there are also third-class brakes with five compartments and two lavatories, and compo-brakes with three first and four third-class and two lavatory compartments. The first-class compartments seat six and the third-class eight passengers.

The carriages are all 65ft. long over the bodies and 68ft. 6ins. over the buffers; 9ft. wide at the waist (with 3½ins. turn under at the floor on each side and 1½ins. at the cantrail) and 12ft. 1in. high from the rails to the top of the roof. It will be seen from our illustrations on p. 226 that the carriages fill the loading gauge pretty fully, and as regards height and width are of the maximum possible dimensions.

The first-class compartments are finished in polished walnut, relieved with gilt scrolls. The upholstering is in brown tapestry moquette trimmed with silk vellum lace. Over the floor linoleum in the non-smoking compartments is laid a Cashmere rug, having a pattern and colour which harmonise with the cushions. The roof and top sides are of Lincrusta Walton treated in white and gold. The four-light electrolier and the metal covers of the window blinds are gilt. The inside of the doors are padded with embossed Morocco leather.

The third-class compartments are finished in mahogany and upholstered with peacock-blue French carpet, having a black floral pattern with orange spots. The floors are laid with thick cork linoleum of a bright pattern, the side and ceiling panels are filled with Lincrusta Walton enamelled white. The seats have shaped spring backs in which the upholstery is carried higher than is usual in such compartments. The cushions are stuffed with curled horsehair, and by means of a special arrangement of the sofa springs the elasticity is extended to the edge of the seat. Four light bronze electroliers fitted with opal shades are provided, and the spring roller blind cases are also bronzed.

Air extractors are fitted on the roof, and there are series of permanently open perforations in the doors leading to the corridors. The drop lights of the doors are provided with draught excuders, and may, by a recently patented device, be held in any desired position. The window sills have sloped recesses for draining off the condensed moisture from the windows. The luggage racks are of corrugated brass wire. The standard passenger communication by means of the brake is fitted. Mirrors and the company's official, hotel, and other notices, including a newly prepared panoramic map of the Caledonian R. and a plan of Glasgow and the district, are used to fill the panels. The ceilings of the compartments and corridors are made symmetrical which undoubtedly improves their appearance.

The floors of the corridors are covered with cork matting which adds to the comfort and their appearance of the carriages, and also protects the main floor from wear.

The lavatories are lined with "emdeca" zinc sheets coloured to imitate tiling. They are supplied with hot and cold water, the former being available in winter when the steam heating apparatus is in use.

The heating cylinders are arranged as shown on the plan and are filled with acetate of soda heated by steam. Each compartment is fitted with controlling handles so that passengers may regulate the temperature of their compartment.

The vans are fitted with bicycle racks and also with a safe for consignments of especial value, and with the switches and handles for controlling the lighting and heating of the train.

The double floors and sides are packed with hair felt with the object of reducing as much as possible the noise of travelling.

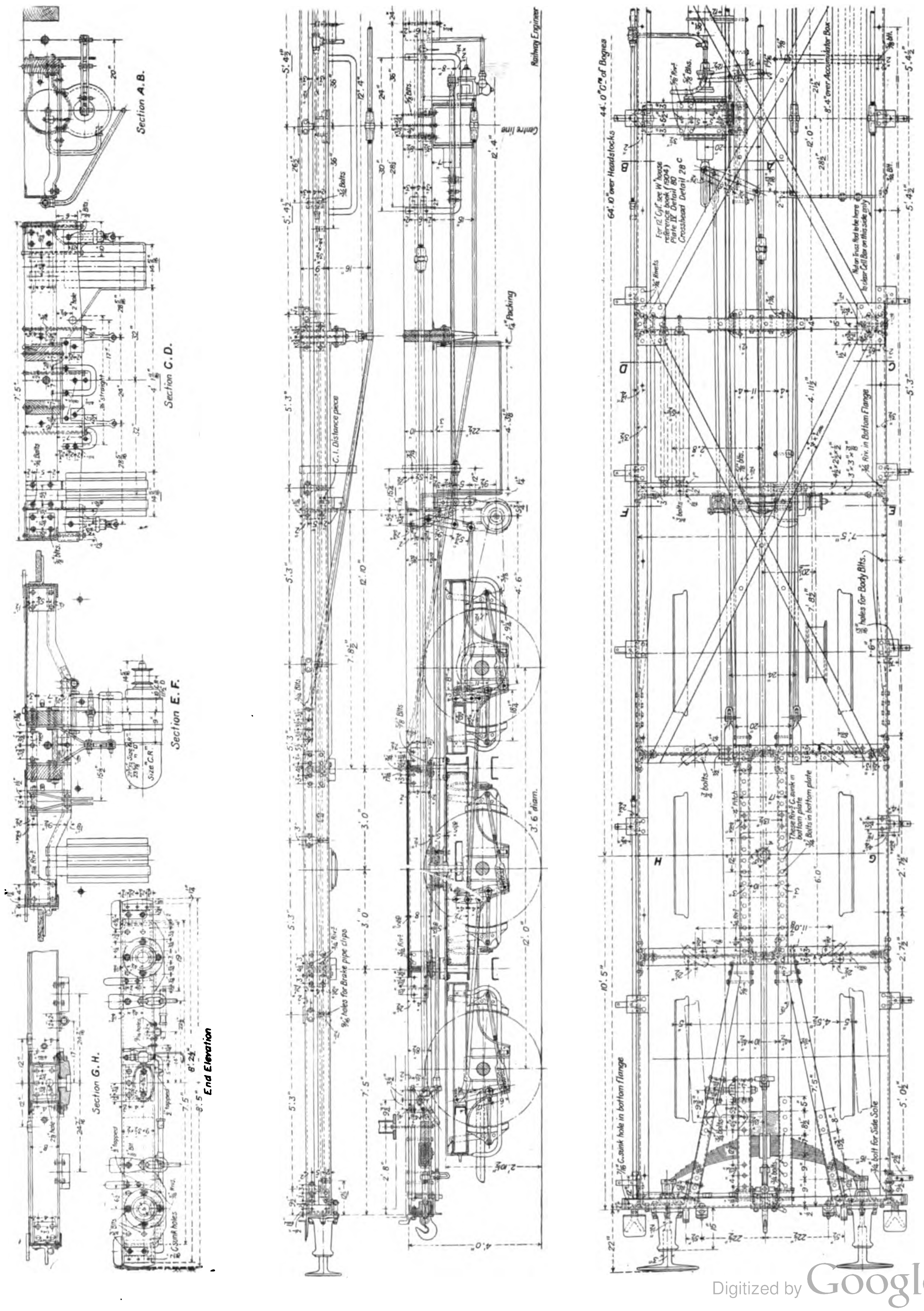
Every effort has been made to secure the easy riding of these carriages, and with that end in view rubber blocks have been inserted between the body and the under frame.

The bogies are of the six-wheeled type, and are constructed entirely of pressed steel plates, as shown by the drawing. The wheel base is 12ft., and the length of the sales 17ft. 3ins. The wheels are 3ft. 6in. diameter on the tread, and the journals 9ins. by 4ins.

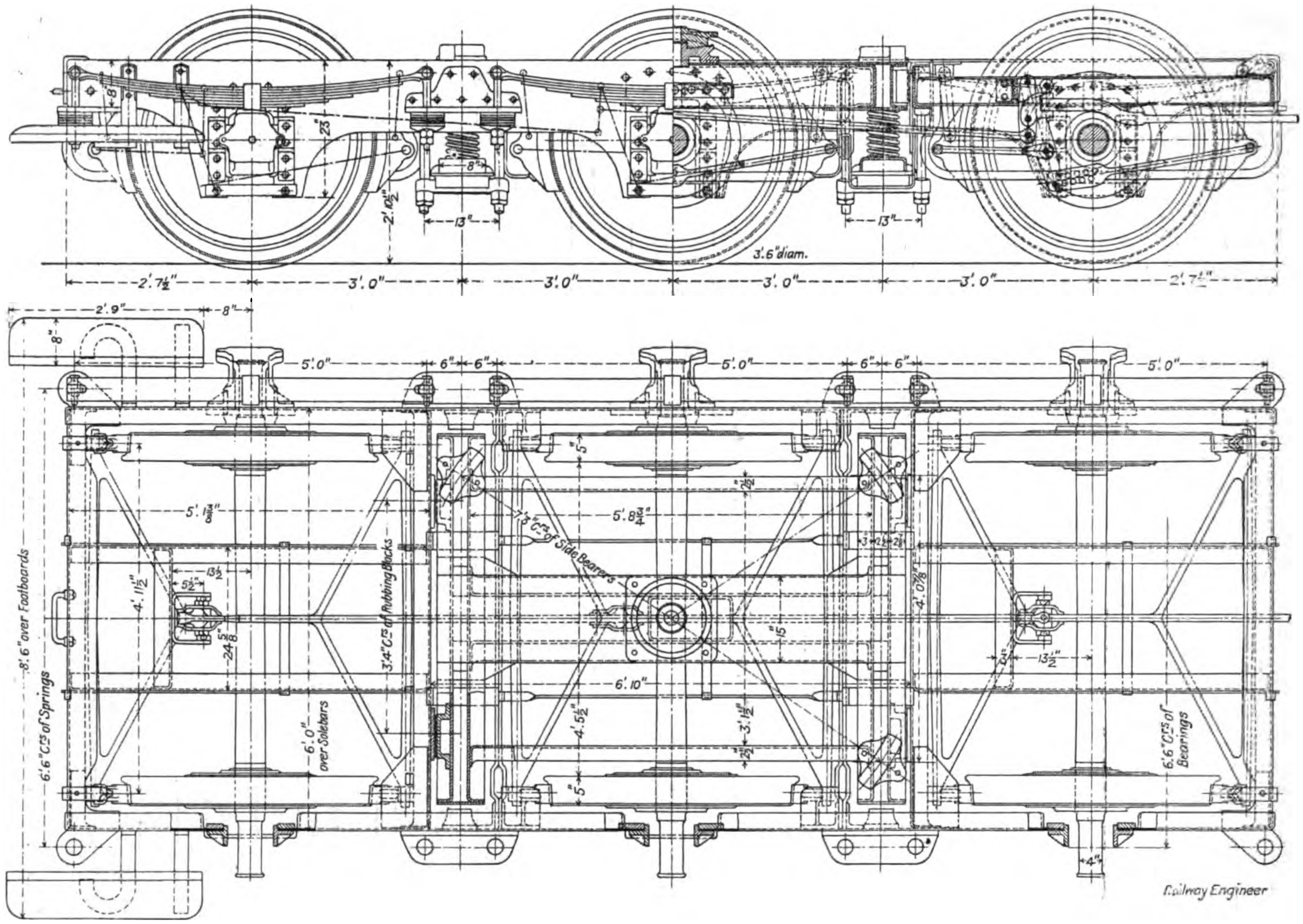
The bearing springs are 5ft. long, and their suspension links are fitted with rubber springs. The bolsters are fitted with coiled springs of Timmis section.

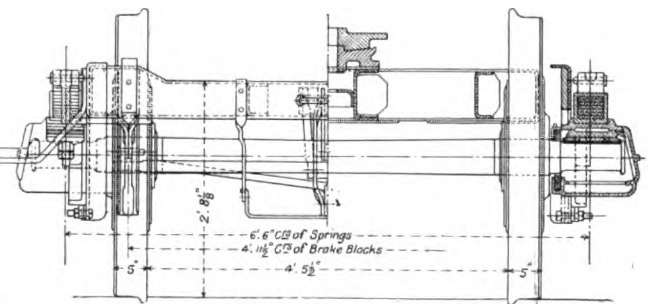
The H bolster is also built up of pressed plates placed back to back, and their flanges connected by covering plates.

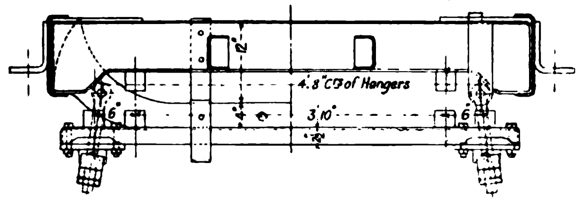
The under-frame is also common for all the vehicles. It is 64ft. 10ins. long over the headstocks and 44ft. between the centres of the bogies; the width over the sale bars is 7ft. 5ins.



Under Frames for 65 ft. Corridor Carriages, Grampian Express; Caledonian Railway.







Six-Wheeled Bogie for 65ft. Corridor Carriages of "Grampian" Express; Caledonian Railway.

It is almost entirely constructed of steel channels and angles with bent corners to connect the members. The soles and headstocks are channels 9ins. by 3½ins. by ½in. The middle longitudinals between at the bogie centres consist of channels 8ins. by 3ins., back to back 10ins. apart, with a $\frac{5}{16}$in. plate covering them, but elsewhere they are of oak, the end lengths and diagonals being 8¼ins. by 4¼ins. and 8½ins. by 3½ins. respectively, and the middle lengths being 10ins. by 4ins. These timber members facilitate the fixing of the plate buffing and draw spring, which is inserted from below and supported by a steel plate bolted up with through bolts, as shown.

The bolster cross bearers are channels 8ins. by 3ins. back to back as shown, and the intermediate cross bearers consist of angles, the under one being 4½ins. by 2½ins, by ½in., and carrying the dynamo and one end of one of the accumulator boxes (see section E. F.). At this point there is a heavy U plate between the timber longitudinals and which carries the brake lever.

The frame has four queen trusses, having a total depth from the top of the under frame of 25ins. to the centre of the truss rods, which are 1¼ins. diam. The posts of the trusses are supported on a cross timber under the soles and let into the middle longitudinals (see cross section C. D.). The other end of one of the accumulators is hung on this member, which is held up by through bolts.

The Westinghouse brake cylinder, 12ins. diam., is fixed at the centre of the frame and is carried on angles between the sole bar and longitudinals, and on the other side of the longitudinals the other accumulator box is supported. (See section A and B).

The bays of the frame are braced diagonally with ribband plates as shown.

The carriages are fitted with the electric light. Each vehicle has its own dynamo, generating current at 24 volts, and two batteries of accumulators, which when fully charged will continue to light the compartments and corridor for 9 hours after the charging current is off. The first-class compartments are allowed 40 c.p., and thirds and corridors 32 c.p. The guard can switch off or on half or all the lights on the train.

Widening Grosvenor Bridge—London, Brighton and South Coast Railway.

By Chas. S. Lake.

When describing the reconstruction of Victoria Station in the August issue of *The Railway Engineer*, the writer incidentally referred to other works which are essential features of the remodelling process to which the railway is at present being subjected, from the designs and under the supervision of Mr. Charles L. Morgan, M.Inst. C.E., the company's chief engineer.

One of the most important of these, and one which is also of great interest to engineers, is the widening of Grosvenor Bridge, which carries the line over the river Thames about half a mile from the southern end of the new Victoria Station. Considerable interest is attached to this work, for not only was the original structure—formerly known as the Victoria Bridge—the first to carry a railway over the Thames at London, but, when the widening works now in hand have been completed, the bridge, taken collectively, will be, it is believed, the widest railway bridge in the world. And in view of the present additions the history of the older structures has also a particular interest.

The bridges formed the subject of two papers read before the Institution of Civil Engineers in 1867, one by Mr. William Wilson, resident engineer under Sir (then Mr.) John Fowler, designer of the bridge; and the other by Sir (then Mr.) Douglas Fox, whose father, Sir Charles Fox, was engineer for the widening works and also for the second bridge thrown across the Thames at the same point in 1865-6. In the first of these papers, which dealt with the design and construction of the original bridge erected in 1859, it is stated that it was not until 1857 that any attempt was made to relieve the public from the delay and inconvenience arising from the fact that all the lines approaching the Metropolis from the South had their termini situated on the southern bank of the Thames, removed from the centres of population and difficult of access. In 1857 the Victoria and Pimlico R. was projected, with the object of extending the railway then terminating in Battersea Fields to a more central position in the West End, where the then existing Grosvenor Canal and Basin offered a favourable opportunity for obtaining a large and commodious station at a comparatively low cost. This railway, although only about one mile in length, involved works of considerable magnitude and difficulty, the chief of which was the bridge for carrying the lines over the Thames. The first stone of the bridge was laid on the 9th of June, 1859, and the first train passed over on the corresponding date of the following year thus only twelve months were occupied in the erection of this important structure. The total cost, including the land arches and abutments, was about £84,000, and as the superficial area of the roadway between the parapets was 31,690ft., the cost per superficial foot worked out at £2 13s. The total length being 930ft., the cost per lineal foot for each line of railway was £45 3s.

The bridge, which after all these years of constant use is, for all practical purposes, in as good condition as the day upon which it was completed, consists of four segmental wrought iron arches, each having a span of 175ft. at the springing, with a rise of 17ft. 6ins.—one-tenth of the span—and a clear headway of 22ft. above Trinity high-water level. At the Northern end there is a land arch or opening of 70ft. span, crossing Grosvenor Road, and at the southern shore there is a corresponding opening of 65ft. span, crossing land belonging to and occupied by the L., Brighton and S.C. R. Company.

With regard to the spans and the positions of the piers and abutments, the engineer had little or no option, as the precise openings had already been settled by works which were at that time (1857) either existing or in course of construction; thus the line of embankment walls necessarily determined the position of the abutment faces, whilst the close proximity of the Chelsea Suspension Bridge—150 yards to the westward—rendered it essential that two piers of the the railway bridge should coincide with those of the adjacent structure, and by dividing the main span of the suspension bridge four equal spans of 175ft. each, with three intermediate piers in the river were obtained.

The importance of these particulars and others that follow lies in the fact that the general design of the new bridge now being erected approximates very closely in several material respects to that of Sir John Fowler, a point to which further reference is made later. The structure was designed to accommodate two lines of rails of mixed gauge, *i.e.*, standard or 4ft. 8½in., for the Brighton and the London, Chatham and Dover trains, and 7ft. 0in. for the Great Western broad gauge trains. A general idea of the appearance of the first bridge, before the present works were commenced, can be gathered from fig. 1. After the arches had been erected and the supports removed, the whole of the iron work was subjected to a severe testing of its strength. This was done by loading each arch with a moving weight of 350 tons, which was equal to a load of 1 ton per lineal foot on each pair of rails.

The deflections were taken with the greatest accuracy by fixed gauges underneath and by levelling from above, the results in each case, when compared, being found to perfectly coincide. Commencing at the north end the load was placed first on the 70ft. opening, extending over the abutment up to the centre of the first arch. The deflection of the 70ft. girders was 0.48 inch in the centre. The greatest deflection in the arch was at a point 60ft. from the abutment and amounted to 0.58in.; at the crown it was 0.38in. The horizontal girder showed a deflection of 0.72in. at 60ft. from the abutment. The same test produced a rise in the adjoining arch to the extent of 0.12in. at the crown, but the third and fourth arches showed no movement. The next test was moving the whole load over the entire span of the first arch, and the deflection produced by this was 0.71in. at the crown of the arch, and 0.56in. at points 35ft. on each side of it. The deflection of the horizontal girder was regular throughout its

Fig. 1.—View of Original Victoria and Pimlico Railway Bridge, built by Sir John Fowler in 1859, taken before present works were commenced.

entire length, commencing at zero on the piers and gradually increasing up to 0.71in. at the centre. The adjoining arch, which was unloaded, showed a rise in the centre of 0.16in. and 0.17in. at 30ft. nearer the load. The horizontal girder also rose to the extent of 0.24in. midway between the pier and the centre of the arch, no change being perceptible in the third and fourth arches. The load was then passed on to the centre of the first pier and extended from crown to crown of the first and second arches; this produced a depression of 0.41in. at the crown of each arch and 0.36in. and 0.24in. in the horizontal girders midway between the piers and the centres of the arch. The second arch was then subjected to the whole load, and the deflection noted was 1.02in. at the crown and 0.76in. at 30ft. on each side of it, the horizontal girder deflecting 0.12in. midway between the pier and the crown. The two adjoining arches rose 0.10in. in the centre, and the greatest rise in the horizontal girder was at 30ft. from the pier, where it amounted to 0.24in. The same load equally distributed over the third arch produced a deflection of 1.08in. in centre and in the fourth arch it amounted to 0.96in. The loads were then removed and a train of engines weighing 1 ton per lineal foot and 175 feet in length was run at full speed over one line. This produced a deflection of 0.40in. in the first arch, 0.48in. in the second, and 0.45in. in the third and fourth arches. After the experiments were completed the arches and horizontal girders were carefully gauged, and the permanent set was found to be so small as to be scarcely appreciable, the readings being 0.10in. in the first arch, 0.10in. in the second and 0.12in. in the third and fourth arches.

The railways designed by Sir Charles Fox, M.Inst. C.E., in 1862 had for their object the improvement of the means of access to Victoria Station, and the scheme, as before mentioned, involved the widening of the existing bridge over the Thames, just as at the present time the widening works designed by Mr. Morgan for improving the capacity of the L., Brighton and South Coast R. have necessitated a further widening of the bridge in question.

Prior to the construction of the works of 1862 there existed, as will have been gathered from the foregoing particulars, only the two mixed-gauge lines of railway to give access to the combined terminus of the L., Brighton and S.C. R. and the L., Chatham and Dover R., and the original intention when the widening works were undertaken was to construct an independent bridge to carry three additional lines of way for the sole use of the Chatham and Dover trains, but it having been determined at the same time to add a third line for the L., Brighton and S.C. R., it became necessary to make arrangements for joining up the new work with that of Sir John Fowler's bridge of 1860. The broad gauge rails were removed from the two existing lines and a third track on the standard gauge was laid down for the Brighton Company's traffic, whilst on the completion of the work the L., Chatham and Dover, and the Great Western trains were provided with two narrow and two mixed gauge lines, carried entirely upon the new structure, the first stone of which was laid on the 22nd February, 1865, and the first locomotive passed over within seventeen months of that date, viz., on the 1st August, 1866.

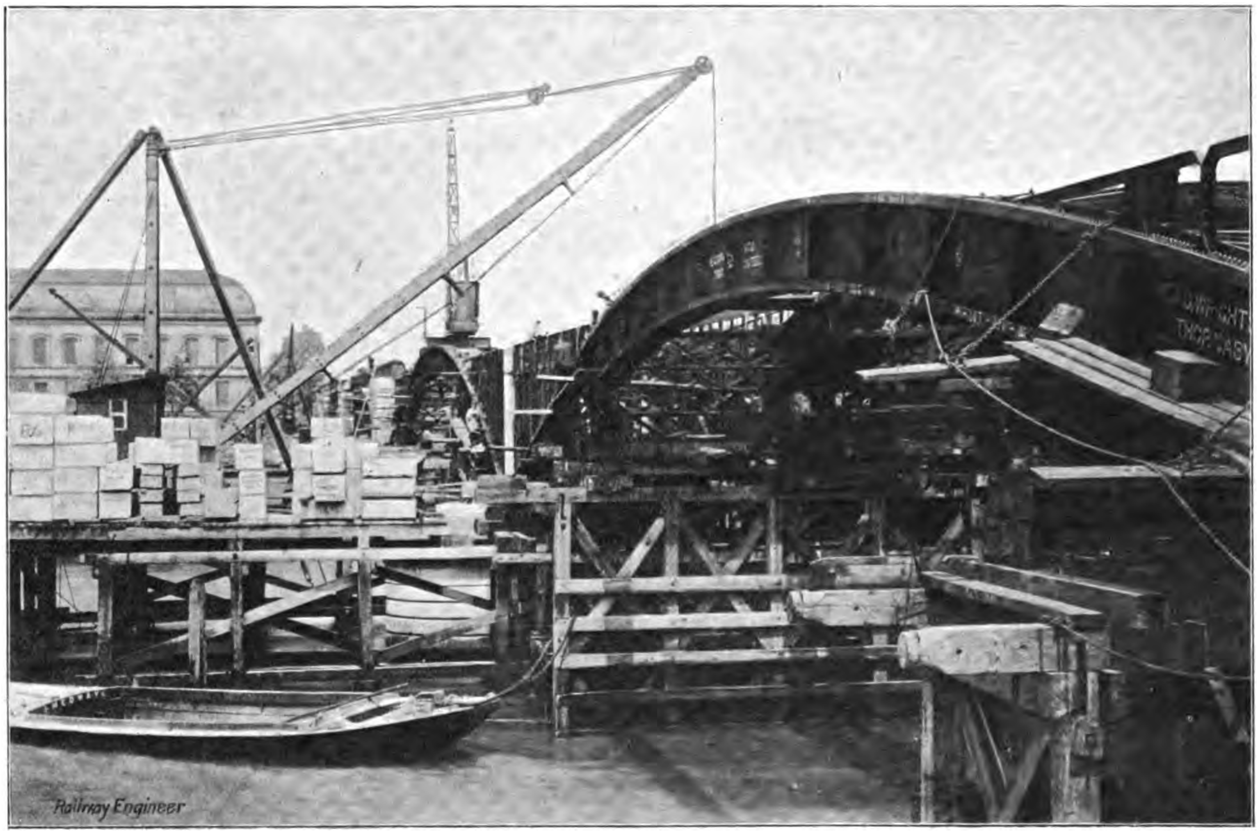


Fig. 2.—View looking North from South Abutment, showing Spans 3 and 4.

In this case the total cost of the bridge was £245,000, equal to about £2 13s. per superficial foot of space covered, or about £38 per lineal foot of single line.

The design of this bridge differed materially from that of Sir John Fowler, although there were of course many features common to both structures, particularly in repect of dimensions, such for instance as the width and rise of the arches and other proportions necessary to make the two adjoining bridges correspond with one another. On the completion of the second bridge the total combined width was 132ft. 6in. between parapets, and the number of lines carried was seven, viz., five narrow and two mixed gauge. There were also platforms on the bridges, one 24ft. and the other 12ft. wide, in connection with the stations at either end, and the portion of the bridge carrying these platforms was so arranged as to admit, upon the addition of one more rib only in each span, of three additional narrow gauge lines, so that the two bridges should be unitedly capable of carrying ten lines of way, viz., eight narrow and two mixed gauge.

Coming now to the bridge at present being erected, this is, as before said, part of the widening and reconstruction scheme of the L., Brighton and South Coast R., and in his design Mr. Morgan has reverted very largely to that adopted by Sir John Fowler in 1859, but there is a marked difference in the details of construction and the materials and methods employed in the work. The accompanying illustrations, from photographs, clearly show the new structure at various stages during erection, whilst the drawings correctly illustrate the details of the design and the proportions employed. The bridge consists of four spans, having a clear opening of 178 feet each. The three piers, which were constructed in cast iron caissons, are built of Swedish granite, the hearting consisting of Staffordshire brindle bricks set in cement. The bull-nosed course and skew-backs are of Cornish granite, and the upper portion of each pier is built of York stone with a hearting of cement concrete. The portion of the pier built in the caisson was brought up to a short distance above low water mark, when the upper portion of the caisson was removed, only the two bottom rings remaining in.

The new portion of the pier was then loaded heavily to guard against settlement, and when the load was removed it was connected to the existing cut-water by cast iron girders and a pressed brick relieving arch.

The portion of the new pier was then bonded in to the old for the remainder of its height.

The widenings provide for two additional lines—an engine line and the new up-main—each of which is carried by a pair of steel arched ribs hinged at the springings. The pins of the hinges are of forged steel, 12in. diameter, with knuckle castings of cast steel. The load is transmitted to the arched ribs by means of vertical spandril columns, built up of standard sections, and a distributing stringer girder transmits the load from the cross girders to the spandril columns. The flooring consists of cross girders and intermediate rail bearers. The four ribs constituting the bridge are thoroughly braced together so as to provide a stiff and rigid structure, and great care has been taken to provide for the effects of expansion and contraction all the way through.

The work includes two approach spans, one at each end of the bridge, and a heavy retaining wall extends from the northern extremity for some distance in the direction of the new terminal station at Victoria. The southern approach span will be connected with the widened lines, now terminating alongside Battersea Park Station, by means of a series of arches and plate girder spans across the Company's extensive goods yards situated at this point. This will involve the demolition of the building at present used for the manufacture of oil gas (Pintsch's system) largely employed for carriage lighting on the L., Brighton and S.C. R. A new building is, however, being erected further down the line in substitution of that about to be pulled down. The widening south of the bridge has also involved cutting through the roofs of two locomotive sheds of the round-house type, a rather intricate operation, and these roofs have now been modified to conform to the altered conditions without the ground area having been interfered with. Considerable ingenuity has been exercised in carrying out this portion of the work which has been effected in a most creditable manner. At a point near Battersea Park Station a further widening has been introduced with the object of providing carriage sidings in addition to the through roads. These side tracks will communicate with those of the main line just before reaching the point at which the bridge is entered upon.

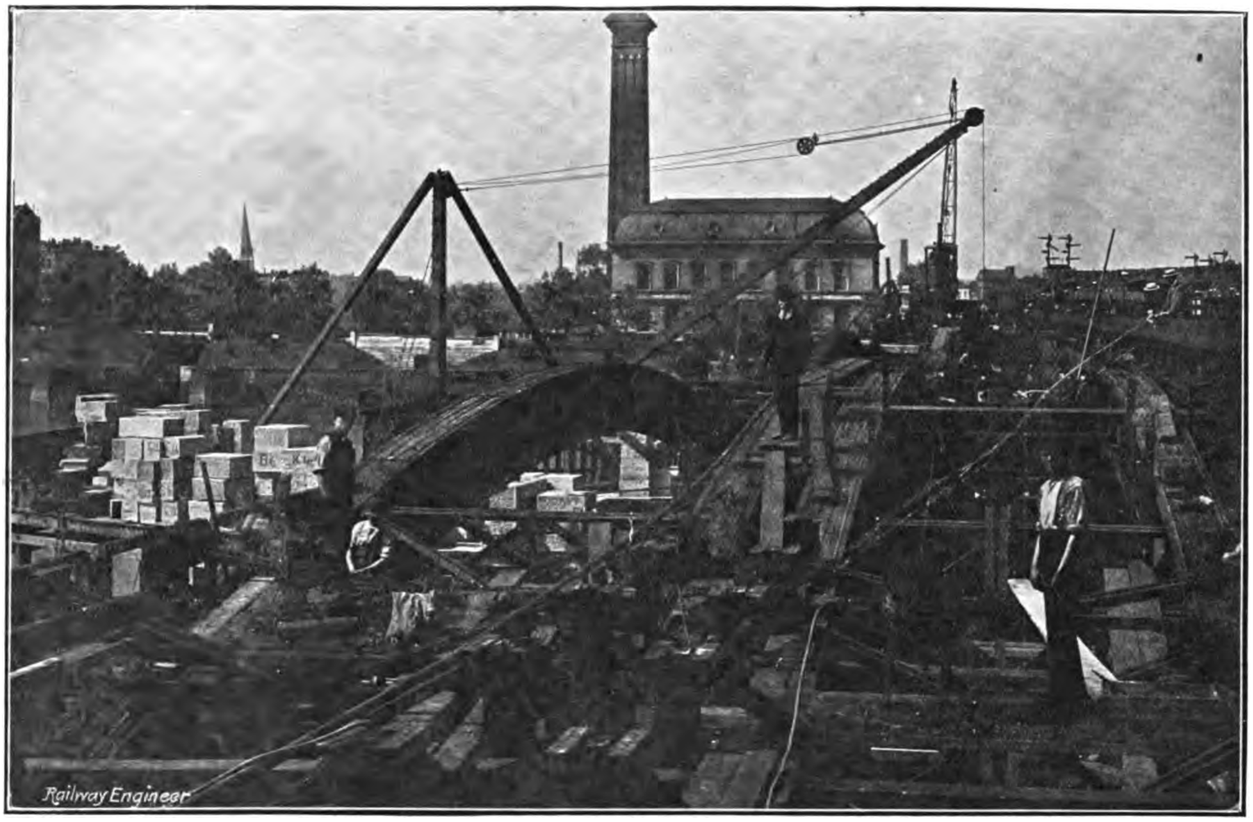


Fig. 3.—View looking North taken from South Approach Span

A further improvement which has been carried out in connection with the general scheme, and one which has considerable importance, is the re-organisation of the arrangements for giving light engines coming from the sheds direct access to Victoria Station. Until this improvement was instituted all locomotives proceeding from the sheds to the terminus had first to pass under the main line, and then, after traversing an incline which brought them on a level with the latter, they were compelled to cross the down main line in order to reach one of the up roads over which they ran into the station. This arrangement resulted in outward bound trains being frequently held up on the bridge to allow of light engines crossing in front of them, the only alternative being that of keeping the latter waiting and thus incurring the risk of the trains which they were intended to haul out of Victoria being late in starting All this has been done away with by the

provision of an incline on the same side of the railway as the up main line, and by this means locomotives coming from the sheds obtain direct access to Victoria by the new engine line without its being necessary to cross over any of the through roads communicating with the terminus. Of the two lines which the new bridge will carry one will be exclusively devoted to the requirements of light engine and empty stock, which will thus not become intermixed with the regular passenger traffic.

As regards the present condition of the bridge, it may be said that No. 1, or the North Span, is practically complete except for the parapet. No. 2, or North Centre Span, is well forward, and Nos. 3 and 4 Spans are also approaching completion. It is anticipated that the bridge will be ready for testing in about three months time, and it may be confidently anticipated to prove an immense boon to the company in conducting their ever increasing traffic in and out of the West End terminus.

When all is completed the three bridges, viz., those of 1859 and 1866 and that of 1905 side by side will have a total width of 178ft., and will carry nine lines. The contractors for the bridge are Messrs. Mowlem and Co., Ltd., of Westminster, the ironwork being sublet to Messrs. Head, Wrightson and Co., of Thornaby-on-Tees.

In conclusion, the writer desires to express his indebtedness in the first place to Mr. Chas. L. Morgan, M.Inst. C.E., Chief Engineer of the London, Brighton and South Coast R., for permission to view the works, and in the second place to Mr. R. E. Synge Cooper, M.Inst. C.E., Mr. Morgan's resident engineer, for his trouble in explaining the details of the design and construction on the site of erection.

Thanks are also due to Mr. Morgan for the photographs and drawings from which the illustrations accompanying this article have been prepared, and also those which will be published in the next issue.

Fig. 4.—View of No. 1 or North Span.

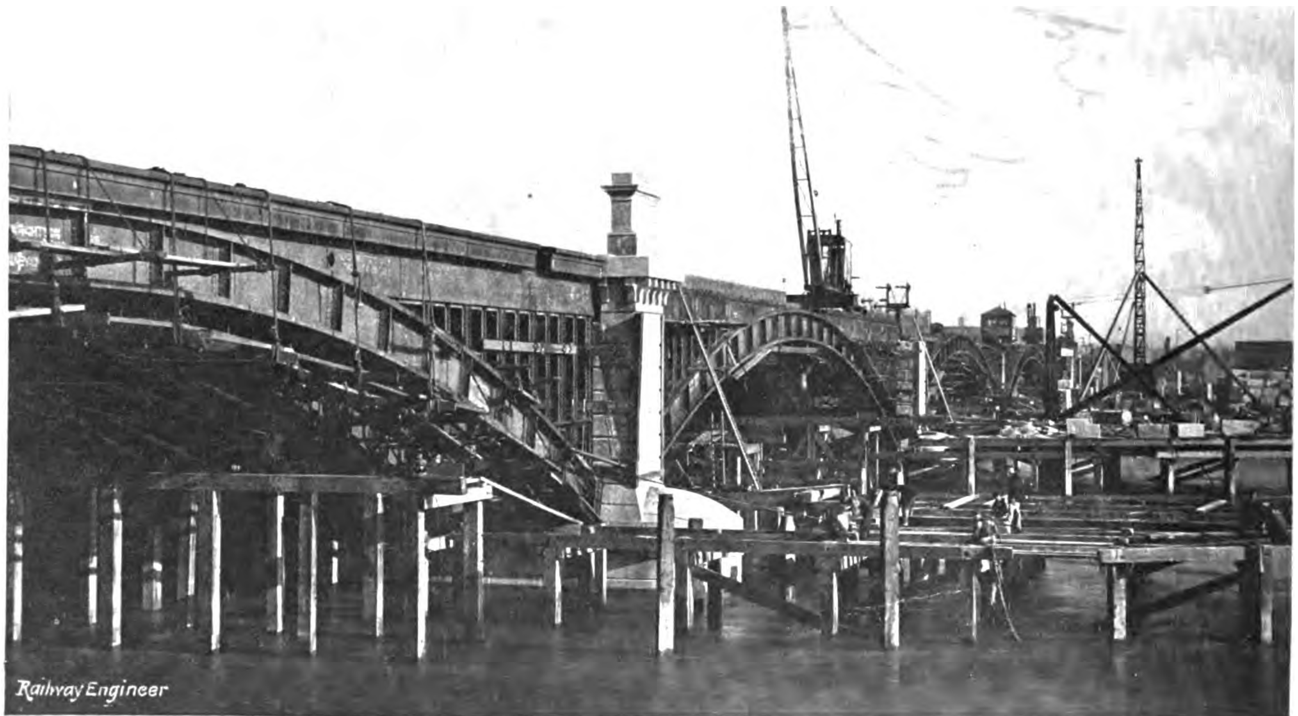


Fig. 5.—View looking South taken from Shore, North Side of River.

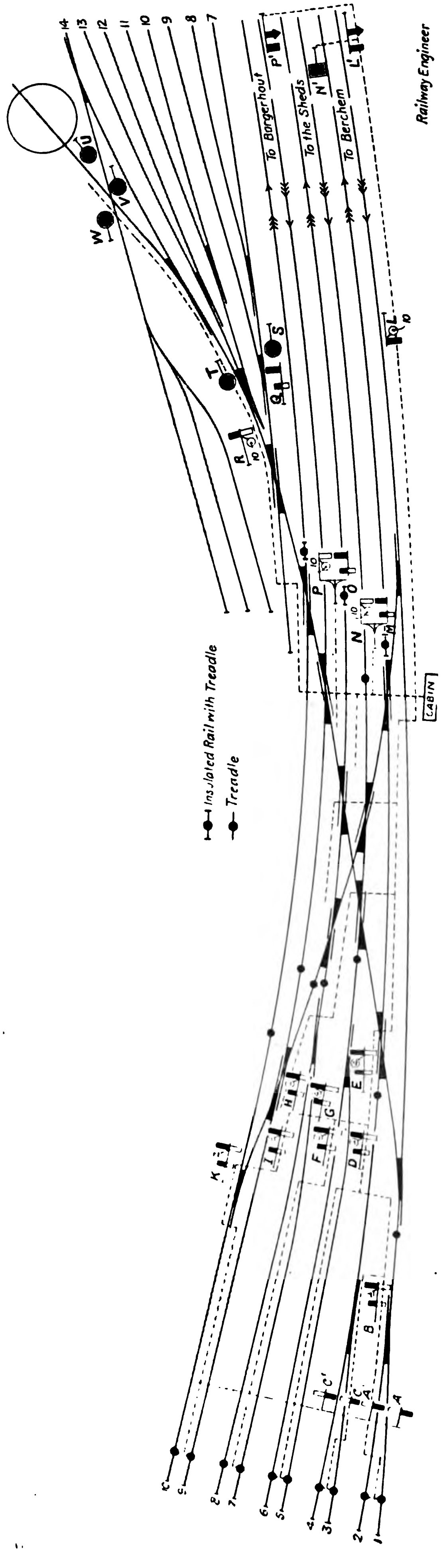


Fig. 1.—Diagram of Arrangement of Signals at Antwerp Central Station.

The Siemens-Halske Power Signalling Plant at Antwerp Central Station; Belgian State Railways.

Before deciding upon a system of power signalling for Antwerp Central Station the Administration of the Belgian State Railways thoroughly investigated the matter, and finally decided that the Siemens-Halske "all electric" system was the one which best suited their requirements. This system is well known on the Continent, where several large installations of it have been laid down, including quite recently one at the *Gare du Nord*, Brussels, comprising four cabins containing 150, 70, 40 and 40 levers respectively.

The writer is indebted to Monsieur L. Weissenbruch, engineer of the Belgian State Railways, for the photographs and drawings from which the illustrations have been prepared.

Fig. 1 shows a general diagram of the station, from which it will be seen that there are 10 roads under the station roof leading to six running roads, which are connected by two through roads with double slips.

The plant consists of 35 levers for points and 17 for signals, besides 33 double route levers and 15 spare levers. To have accomplished the same work mechanically would have required 180 levers.

The plant is divided into what are technically known as "fields," of which there are three kinds, viz., "switch fields," "route fields," and "signal fields."

"Switch fields" operate the points, and their levers are painted blue. The switch lever is normally to the right, and is held in position by a notch in its frame, there being a corresponding notch for the "over" position, which is through an angle of about 80° from normal to the left. Below the lever is a small frame with two windows, one above the other. Behind the upper window a blue disc appears; if any vehicle be on the switches a white disc if the line be "clear." These indications are obtained by means of the insulated lengths of track, referred to below. The lower window has also two indicators—white and black. White indicates that the switches are closed, and correspond with the position of the lever, whilst the appearance of the black disc, accompanied by the ringing of a bell, indicates that the switch motor is moving, or that the switches are run through and burst.

The "route-fields" play a very important part. They save many levers, guarantee that the road is properly set before the signal is lowered, and also "hold" the road. The lever of a "route-field" is painted green, and stands normally in a mid-position. It is turned to the left for one route and to the right for another route. The releasing numbers—*i.e.*, those of the point-levers that have to be "over" to make the route—are marked on a plate above the lever, together with the route the lever in that position gives.

Under the "route-lever" is a frame with one window, behind which appears either a white or a green disc. The normal is the white one, which changes to the green one when the lever is moved, and the latter is at once locked and remains so until the train has passed over an electrical contact at the end of the route. By this means the road is "held."

The "signal-field" is for working signals and its lever is painted red. It is normally inclined to the right, and is pulled to the left to lower a signal.

A "signal-field" has two windows. Behind the upper one are given three indications. A red disc which is normally shown

disappears when the route-lever corresponding to the signal is pulled over, leaving the red horizontal bar, which was in front of it and which shows up against the white ground behind it, when the first disc is withdrawn and indicates that the signal is at danger. The red bar is withdrawn leaving the white ground only visible when the signal is "off."

The lower window has the same indications, and is for the same purposes as the lower window of the "switch-field." It shows black when the signal motor is operating and white when the signal corresponds with the lever.

road is set and allow for one signal arm to serve the purpose of two or more.

Fig. 2 illustrates signal E, fig. 1, for leaving and arriving at No. 5 road. The upper left-hand arm is for departure, and its lower arm is for shunting out. The upper right-hand arm is for a train arriving in the station and its lower arm is for shunting in.

Fig. 3 illustrates the same post with the departure signal "off" and the route indicator showing that the road is set for G (sidings).

Fig. 2.—Signal "On."

Fig. 3.—Signal "Off."

The points and signals are actuated by a 110-volt current known as the coupling or working current, but this is only switched on when a movement is necessary. At other times a 25-volt current is available, and this is known as the "controlling current."

A signal lever can work any one of a given number of arms by the use of an electrical selection associated with the "route-fields," and by this means a large number of signal levers have been saved.

A reduction has also been made in the number of signals by the use of route indicators. Like Annett's route indicators on the L. and South-Western R. they show for what direction the

It will be noticed, fig. 3, that the arm in the "off" position points upward. This is the German practice. It gives a more distinct signal, and should an arm drop it does not give a clear signal.

The utility of the indicators will be appreciated when it is stated that each of the three arrival lines can lead to any of the ten platform-roads. Yet only one signal is provided. It has a screen upon which appears the number of the road for which the line is set.

Each platform is protected by a stop-signal at the end of the platform.

For leaving each platform there is a starting-signal with

screens showing for which the road is set—either of the three main-lines or the sidings.

Lower shunting arms are provided on most of the signals to govern shunting operations.

All facing-points—and practically all the points at Antwerp are facing-points—are provided with "Jüdel" facing-point lock. No locking bars are provided as the lever working the points is controlled by a section of insulated rail adjacent to the points. An advantage of this is that any length of rail can be protected, whereas the permanent way will often prevent ordinary mechanical locking bars being fixed.

One of the well-known advantages of power-signalling and interlocking plants is the absolute guarantee given that the lever has done its work, and that the switches are fully over (and bolted if facing points), or that the signal is at danger. This is obtained by a check lock, which holds the lever in its travel, and its full movement cannot be obtained until the return indication has come, intimating thereby that the purpose of the movement is attained, and that the points are over or the signal gone to danger. This, however, as we have previously pointed out, compels a signalman to "stand by" and wait for the return indication, and when six or eight levers are required to be pulled over to "set up" a road that this is done more quickly mechanically than by power.

In the Siemens-Halske system this objection is removed, as the levers are pulled fully "over" and put fully "back" at one stroke, and the switches are detected by other means, which is the use of the "route-fields." These are locks in the interlocking which are affected by the return current from the points and cause conflicting point and signal levers to be locked and consequent ones to be freed. The signalman is therefore able to pull all his levers over with all possible rapidity, but he may have to pause before pulling the signal lever for the current to return from the various switches to release the "route-fields."

When a vehicle is on the track circuit a magnet in the locking frame attracts a lever, one end of which falls against a pawl on the point lever and when the lever is attracted by the insulated rail magnet the pawl is held and the points cannot be moved from the position they are in.

It has not hitherto been considered necessary in other power plants to give an "off" indication for signals, but only the "on" or danger position. In the Antwerp installation both positions are recorded. The "off" indication is useful for preventing a second signal to be released, being lowered unless the first is fully "off."

The points-operating mechanism is illustrated by figs. 4 to 7. Fig. 4 is a general view of the apparatus with the cover removed; fig. 5 a view of the motor lifted out of the box. Fig. 6 is a sectional drawing of the mechanism, and fig. 7 a diagram showing the electrical connections.

The box is supported on two wrought iron brackets projecting from the ends of adjacent sleepers and the bottom (outside) of the box is not lower in the ground than half the depth of the sleepers.

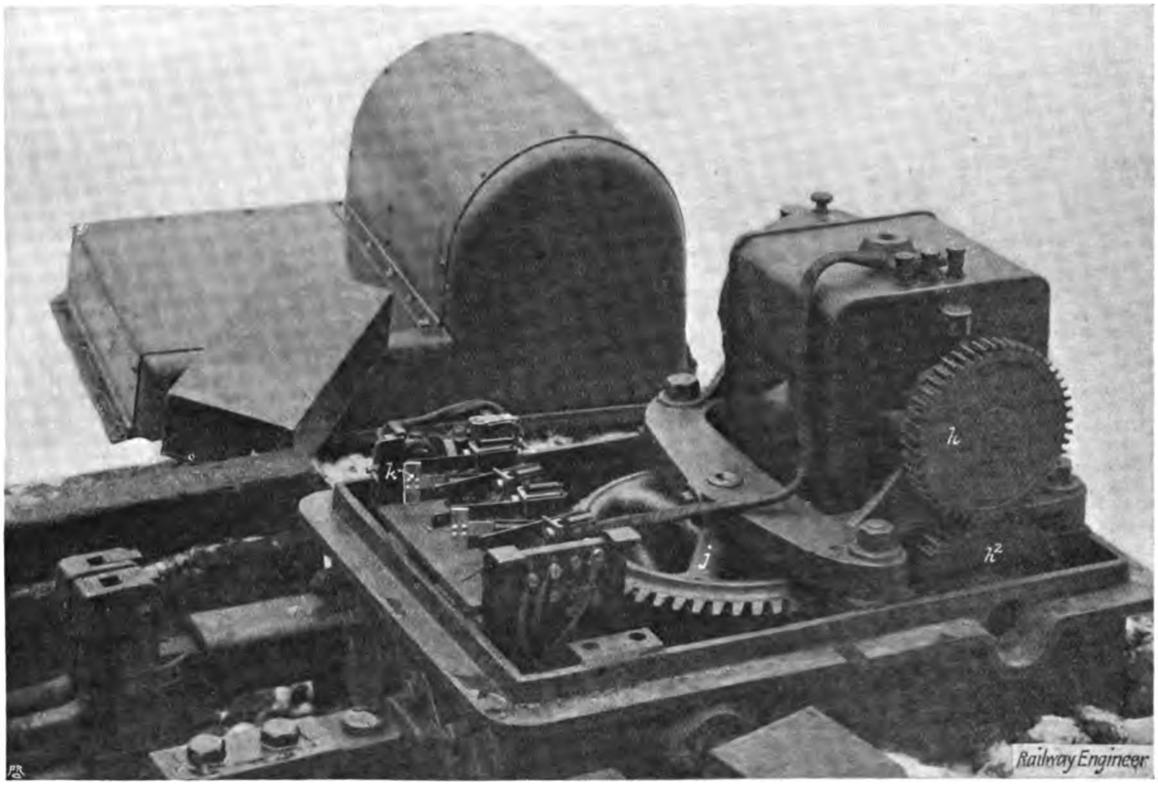


Fig. 4.—View of Apparatus for Operating Switch; Cover removed.

The points are coupled to the rack a which is operated by a pinion b cast on to the underside of a circular plate b^2, on the upper side of which there is a projection $c\,c$ by means of which the pinion is driven. The motor by means of the spur wheels $h\,h^2$ drives the spindle i carrying a worm j which drives the worm-wheel g. The rim (inside) of the worm-wheel is fitted with a friction clutch consisting of a steel band f having its ends pressed apart by two bars $e\,e^2$ separated by a stretcher bar d and connected by an adjustable spring d^2. When the worm-wheel is rotated it carries the bars against the projection $c\,c$ of the pinion plate b^2 above mentioned. The object of this friction clutch is to allow the points to be "run through" without damaging the mechanism. On Continental railways, particularly in Germany, it is considered essential to provide for this contingency.

The edge of the plate b^2 is stepped to form cams, which, as b^2

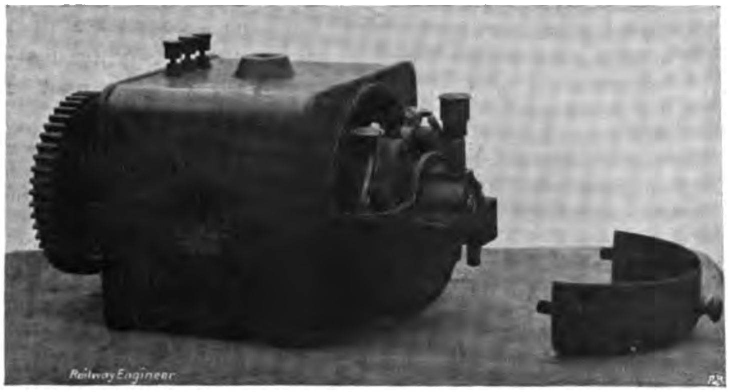


Fig. 5.—View of Motor taken out from Switch Apparatus.

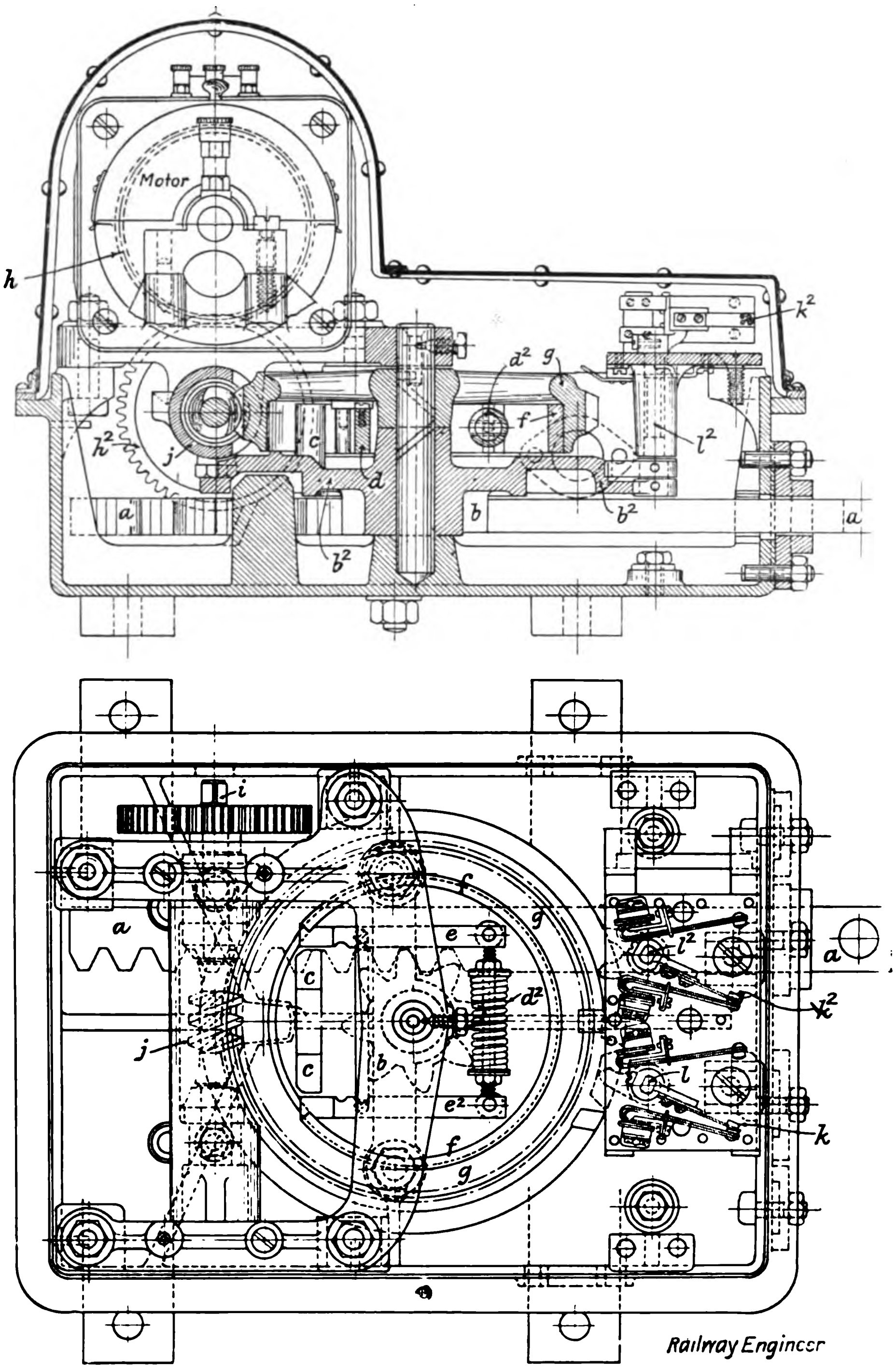


Fig. 6.—Apparatus for Operating a Switch.

Fig. 7.—Arrangement of Apparatus for operating a Switch.

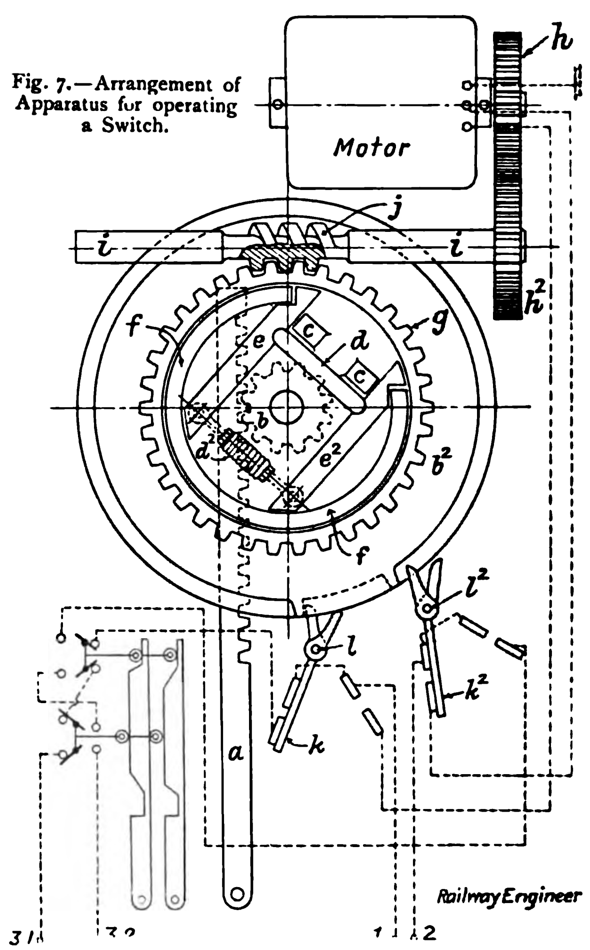


Fig. 8.—View of Apparatus for Operating a Signal.

is rotated, more tappets attached to vertical spindles $l\,l^2$, which at their upper ends carry switches $k\,k^2$. The former k brings into operation an "economiser commutator" in the locking frame. When the point lever is moved to the left the interlocking is actuated, and a switch—the "economiser commutator"—is moved from contact with one set of springs into contact with another, fig. 7, and this switches off the 25 volt controlling current, and switches on the 110 volt to operate the motor.

The initial movement of the point motor being given the circular plate b^2 travels a certain distance and than moves the switch k, fig. 7. This causes to be sent to the locking frame a current which de-energises an electro-magnet, and its armature falling a tumbler is raised that switches the "economiser commutator" back to the 25 volt current, which provides sufficient power to complete the revolutions of the points motor.

The switch k^2, fig. 7, governs the direction in which the motor shall run, according to the position of the points.

And an indication of this would be given in the lower window under the signal lever in the locking frame, and the lever would have to be restored to normal before the signal could be again pulled off even if the magnet at the signal were again energised.

On the right in figs. 2-3 the signal cabin is discernable. It is 48ft. 3in. long by 12ft. 9½in. wide on the floor of the signal cabin, and the apparatus is fixed at the back so as to give the signalmen free access to the windows.

The cabin has an ornamental exterior to correspond with the architecture of the station. No wood has been used in the main structure with the object of reducing the risk of fire. A central hot water apparatus has been provided, the furnace being placed in a separate apartment on the ground floor so as to keep dust, &c., away from the frame, &c. The furnace only requires recharging every 13 hours, and consumes 3 *kilogs.* (6.6lbs.) of fuel on an average per hour during ordinary winter temperatures.

The power is obtained from three batteries of Tudor accumulators which are calculated to be able to do the work, without recharging, for three days. The first of these batteries is the 110 volt for working, and has a capacity of 60 ampere hours; the second is of 25 volts for controlling and has a capacity of 120 ampere hours, and the third is a battery of 3 cells for track circuit. The first two batteries consist of 60 cells each, and are recharged every day by means of a continuous current dynamo, of 5 h.p. at full load, supplying a current of 27 to 20 amperes at a voltage of 110 to 165 volts and making 1,750 revolutions per minute.

The total cost of the installation, including the cabin, was 258,000frs. (£10,320) made up as follows:—Locking frame in cabin, 80 fields, 35 point-levers, 17 signal-levers, 33 double-route levers and 15 spares, 35,244·5frs.; 35 point-motor mechanisms, 44,995·0frs.; 19 semaphores, 67,677·5frs.; 21 electric contacts, 4,836·0frs.; 28 insulated and armoured cables, distributors and terminals, 38,681·5frs.; batteries, &c., 15,540·5frs.; insulated

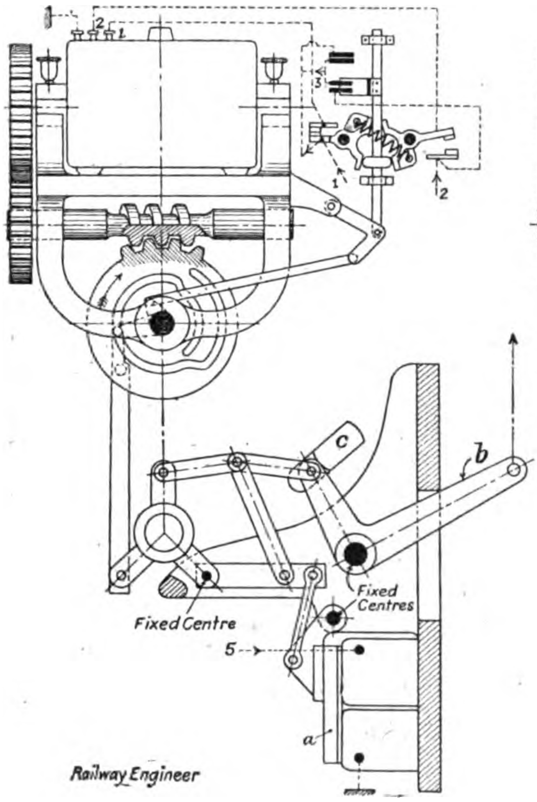


Fig. 9. Arrangement of apparatus for operating signal. Coupler current closed, signal at danger.

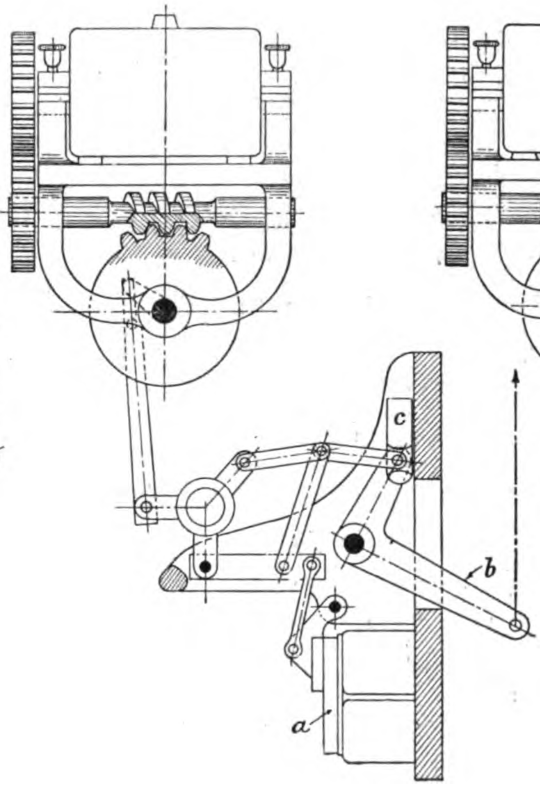


Fig. 10 Arrangement of apparatus for operating signal. Coupler current closed, signal at safety.

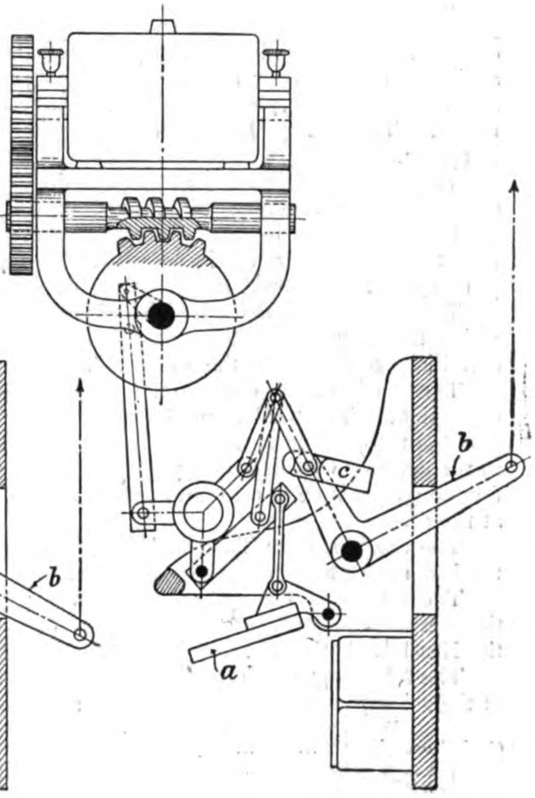


Fig. 11. Arrangement of apparatus for operating signal. Coupler current interrupted.

Detectors coupled to each rail of the points are provided, through which the controlling current returns.

Fig. 8 illustrates the signal mechanism.

The motor is practically the same as that for a switch.

Each signal, or each route indicator, if there be more than one arm, is provided with an electric clutch. If there be more than one that clutch is energised that is applicable to the state of the road.

Fig. 9 shows the clutch a attracted by the electro-magnet, and consequently when the motor is worked the position of the mechanism is as seen in fig. 10, and the upright rod which is coupled to the lever b is pulled down. If the road be not properly set the controlling current would not enter the magnet; or, if after the signal was "off" the current were interrupted (as for instance, the points being run through and burst), the magnet would be de-energised and the clutch would fly away, and consequently the signal would go to danger as shown by fig. 11.

rails, and making good, 10,040·5frs.; labour, 14,000·0frs.; building cabin, 27,000frs.

Fuller details of the various items are given in the description of the Antwerp Installation, written by M. L. Weissenbruch for the Bulletin of the International Railway Congress. M. Weissenbruch estimates that the signalling at Antwerp might have been done mechanically with two s gnal boxes at a cost of 107,550frs. (£4.302).

The wages of 9 signalmen (£421 per annum) are saved, but the wages of an electrician, cost of electricity (£18), interest sinking fund on extra capital outlay have to be put against this saving and reduce the saving to £59 per annum.

Natal Government Railways, 1904.

The annual report of the general manager, Sir David Hunter, is a lengthy. instructive and fully illustrated document, of which the following is a very condensed abstract:—

The total revenue amounted to £1,933,934, as against £2,561,552 in 1903, a decrease of 24·50 per cent. The working expenditure amounted to £1,531,210, or 79·18 % of the revenue, against £1,791,108 or 69·92 % in 1903 (a decrease of 14 51 %), and included £129,702 expended upon additions and improvements. The net profit, after deducting interest on capital, was £17,514.

There was a decrease of 117,212 in the number of passengers and a drop in revenue therefrom of £30,248. The falling-off in the local traffic was 145,8 6 passengers and £40,421 in revenue, but the through traffic increased by 28,674 passengers and £10,173 9s. in receipts.

The goods traffic decreased by 280,104 tons and £593,082, which attests the general shrinkage in the trade and industrial conditions of Natal and the Transvaal.

The coal traffic during the year has shown continuous expansion. The total volume of public coal traffic amounted to 669,896 tons, being an increase of 163.443 tons, but the increase in the revenue was only £9,733. This is due to reduced rates for the conveyance of coal, and the rebates upon all coal shipped at the port.

The receipts from Transvaal traffic amounted to 54 % of the total in 1903; the proportion was 56 %.

The length of the railways open was 775¾ miles, excluding the section Van Reenen to Harrismith (23½ miles) worked by the Natal Railway Aministration for the Central South African R.

The following table exhibits the yearly results of the working of the railways at intervals of ten years:—

Year	1884.	1894.	1904.
Capital open lines	£2,345,946	£6,078,489	£11,170,487
Cost per mile open*... ..	21,874	15,234	15,004
Average miles open for traffic	107¼	399	744½
Earnings	£143.272	£465,872	£1,933,934
Working expenses	137,279	294,063	1,531,210
Balance	6,193	171,809	402,724
Interest charges	124.284	253,378	385,210
Net profit or loss	118.092	81,570	17,514
Working exs to earnings ...	95·67%	63·12%	79·18%
Per average mile open—			
Earnings	£1,336	£1,168	£2,598
Working expenses... ...	1,268	737	2,057
Return	68	431	541
Per train mile—			
Earnings	74·59d.	81·42d.	108·14d.
Working expenses	71·36d.	58·96d.	85·62d.
Return	3·23d.	34·46d.	22·52d.
Passenger journeys	464,496	649,136	2,717,595
Goods tonnage	215,706	336,553	1,771,978
Coal tonnage (included in above)	Nil.	104.963	669,896
Train miles	460,977	1,196,824	4,292,028

* Includes equipment and excludes cost of permanent way and works of Natal-Zululand and Zululand Railways.

The permanent way material was originally 40lbs. to the yard iron rails; to-day the standard is 78lbs. steel rails, shortly to be increased to 80lbs. to harmonise with the rails recommended by the British Standards Committee.

The first engines weighed 29 tons, and had a paying load capacity over the ruling gradient of 30 tons; the latter has now been increased by the latest design of engine to 125 tons.

The original wagons had a capacity of 6 tons; the latest standard has a carrying capacity of 35 tons, or nearly six times the original load.

The eight-coupled tender engines designed by the locomotive superintendent (Mr. D. A. Hendrie) commenced to arrive in October, and at the end of the year 14 were running. The 6-wheeled tender engine (Hendrie engine A), which is a modification of the 8-coupled engine, is intended to work the passenger train service between Ladysmith and Newcastle, and will be capable of taking forward to the terminus the heaviest train brought by the 8-coupled engines to Ladysmith. Two experimental engines of this type are in service. To turn these tender-engines 65ft. turntables, worked by electric power, are being laid down.

The Leeds Forge Co. have supplied 190 wagons to the designs of the locomotive superintendent during the year, and placed in traffic. This type of wagon has a tare of 14 tons 1 cwt. and carries 35 tons. The 10 American wagons referred to in the last annual report have not yet arrived

During the past 10 years practically the whole stock has been re-axled, and broken axles are now practically unknown. The maximum carrying capacity of the 20 ton stock was, as the result, increased by 10 per cent., which is a great economical advantage.

During the year eighteen 8-wheeled carriages were constructed in the carriage shops, and thirteen sleeping and dining corridor carriages were put in hand.

The work is well under way. The vehicles are being well and substantially built, and by constructing them locally, a step rendered economically practicable by the remodelling with modern machinery of the saw mill, and extended carriage shop accommodation, it has been possible to spend in the Colony the wages involved in the construction of the vehicles, which will see longer service than can be obtained from the imported stock. the latter, which have to be shipped in sections, losing to a certain extent in stability. With the experience so far gained it seems that all future additions to the passenger stock might well be constructed in the Colony, but this involves a steady and persistent policy, and the granting of funds to carry it into effect.

The vehicles will be 61ft. long—the size of the new standard passenger stock—and will enable a larger number of passengers per train to be conveyed than has hitherto been possible.

Considerable progress was made with the new erecting, boiler and machine shops at Durban, and new accommodation should by now be available. The new carriage and wagon repairing shops were completed and occupied in March, 1904. The machinery in the saw mill is now all electrically driven, thus further concentrating the development of power in one building.

The new power house at Durban was brought into operation in July, 1904, and at the end of the year was working most satisfactorily and economically. It has been demonstrated that a low class of coal can be burned in the furnaces of this station, and this will tend to increased economy, which, combined with the centralisation so conveniently obtained by the employment of electricity, is estimated to effect an annual saving in the coal bill alone of £3,500. The plant and building have been arranged so as to permit of easy expansion when a demand for additional power arises, at a minimum expenditure in both capital and working costs, and the new power station will demonstrate the value of a central power plant.

The growing employment of electricity suggested the utilisation of the power station at Durban to secure greater efficiency and economy in the working of the shop and other machinery, and after the whole question had been very fully discussed in the Colony the matter was finally referred to the consulting engineer (Mr. H. G. Humby, M.Inst.C.E.) for the purpose of collecting all available information on the subject, and recommending the best course of action. He reported upon the utility of electric current for the driving of the machinery, and plans were prepared by him upon which plant for a modern power station was ordered. The plant obtained, and now working in a highly satisfactory manner, is capable of furnishing a maximum of 900 horse-power. There are five boilers, mechanically stoked, and with the object of reducing the consumption of coal to a minimum Green's economiser for heating the feed-water and condensing plant and super-

heating arrangements was provided. By these various means the coal bill has been reduced to 25 per cent. of the previous expenditure, while the power developed has been largely increased. It is gratifying to state that the policy adopted has more than justified itself, for by the concentration of the production of power in one building all successive additions to the machinery of the department will be worked at the minimum cost, and the power may be applied at any point within a radius of several miles from the power station without any further arrangements than the leading of the necessary electric cable and the provision of additional generating power and transformers. The power station is at present working the whole of the machines in the locomotive shops.

The introduction of electric cranes, the maximum capacity of which is 35 tons each, has revolutionised the working of this shop.

An experimental steam navvy has been ordered and will shortly be employed to demonstrate whether this mechanical appliance, which has been so successfully used in other countries, can be applied with advantage in Natal. In view of the many works before the department in improving the grades and curves on the main and branch lines, it is anticipated that there will be ample work for this machine, the working of which will be watched with great interest. As an auxiliary to the working of the "navvy" a number of tip trucks are to be built in the railway shops out of partly old and new materials.

The nurseries, inaugurated in 1899 under the charge of the late Mr. Coulson, are making continuous progress. The site selected was in the vicinity of Inchanga, where the department had spare land and a water supply. Mrs. Coulson has been acting as the curatrix with eminent success.

The nurseries despatch young plants to the staff at the various stations along the line, and by this means it is hoped, in the course of a few years, the station surroundings. as well as the grounds adjacent to the houses occupied by the staff, will be well laid out with suitable ornamental and fruit trees and their appearance greatly improved. In 1900 the plants, &c., sent out numbered 882, but in 1904 the number rose to 7,852.

The important question of planting hardwood trees suitable for sleeper purposes has not been overlooked, and the following seedlings are growing in the nurseries and will be ready for transplanting in December, 1905:—Eucalyptus Paniculata (ironbark), 9,000; Eucalyptus Liderophoia, 9,000; Eucalyptus Marginata (jarrah), 2,000; Quercus Robusta (English oak), 1,000.—Total, 21,000.

Enlarging and Remodelling Victoria Station; London, Brighton and South Coast Railway.—II.

DETAILS OF THE ROOFING.

In our last issue we published an illustrated description of this important work, which is being carried out to the designs of Mr. Chas. L. Morgan, M.Inst.C.E., engineer-in-chief to the L., Brighton and S.C.R. by Messrs. Mowlem and Co., Ltd., Westminster, and which is now nearing completion. One of its most important features is, of course, the roof, and of this we are able, by Mr. Morgan's courtesy, to publish full detail drawings, which will, we feel sure, be of great value and interest to our readers.

The illustrations on pp. 261 to 268 are exact reproductions of the actual contract drawings to which the roof has been constructed. and as they are fully dimensioned and noted it is quite unnecessary to say more about them.

The roof, it will be remembered, covers an area of about eight acres.

Ferro-Concrete, and some of its most Characteristic Applications in Belgium.*

BY M. ED. NOAILLON, OF CHENEE, NEAR LIEGE.

Properties and Advantages of Ferro-Concrete.—Ferro-concrete is a material which was unknown to the general public a few years ago, but has now entered with phenomenal rapidly into all branches of constructional work. This result is due to its remarkable properties, which may be stated as follows:—

1. The economy rendered possible by its use as compared with other competitive systems.

2. Its resistance to fire, which is now put beyond doubt by numerous tests, some made for the purpose and others the result of accident. It is moreover the only flexible material which possesses this quality of fire resistance; and after the results of the disastrous fire at Baltimore it is clear that very little confidence can be felt in the use of metallic frameworks covered with thin coatings of refractory materials.

3. It is unaffected by atmospheric action. Concrete is from this point of view comparable with stone of the best quality and it improves with age. As to the metal built into the concrete, it has been proved that it is perfectly preserved without loss of weight, and that even if used in a rusty state it will recover after some time the bluish tint which it pos-

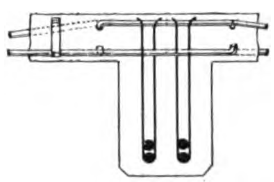
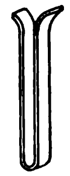


Fig. 1. Section of Beam Hennebique System.



Stirrup.

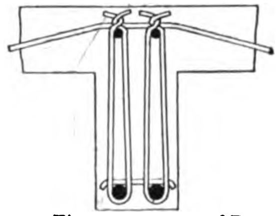
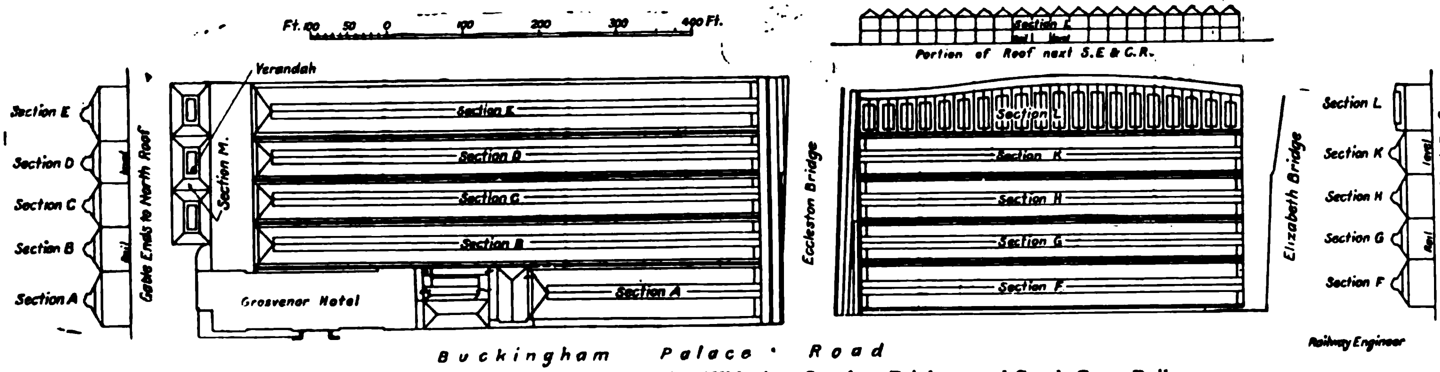


Fig. 2. Section of Beam Coignet System.

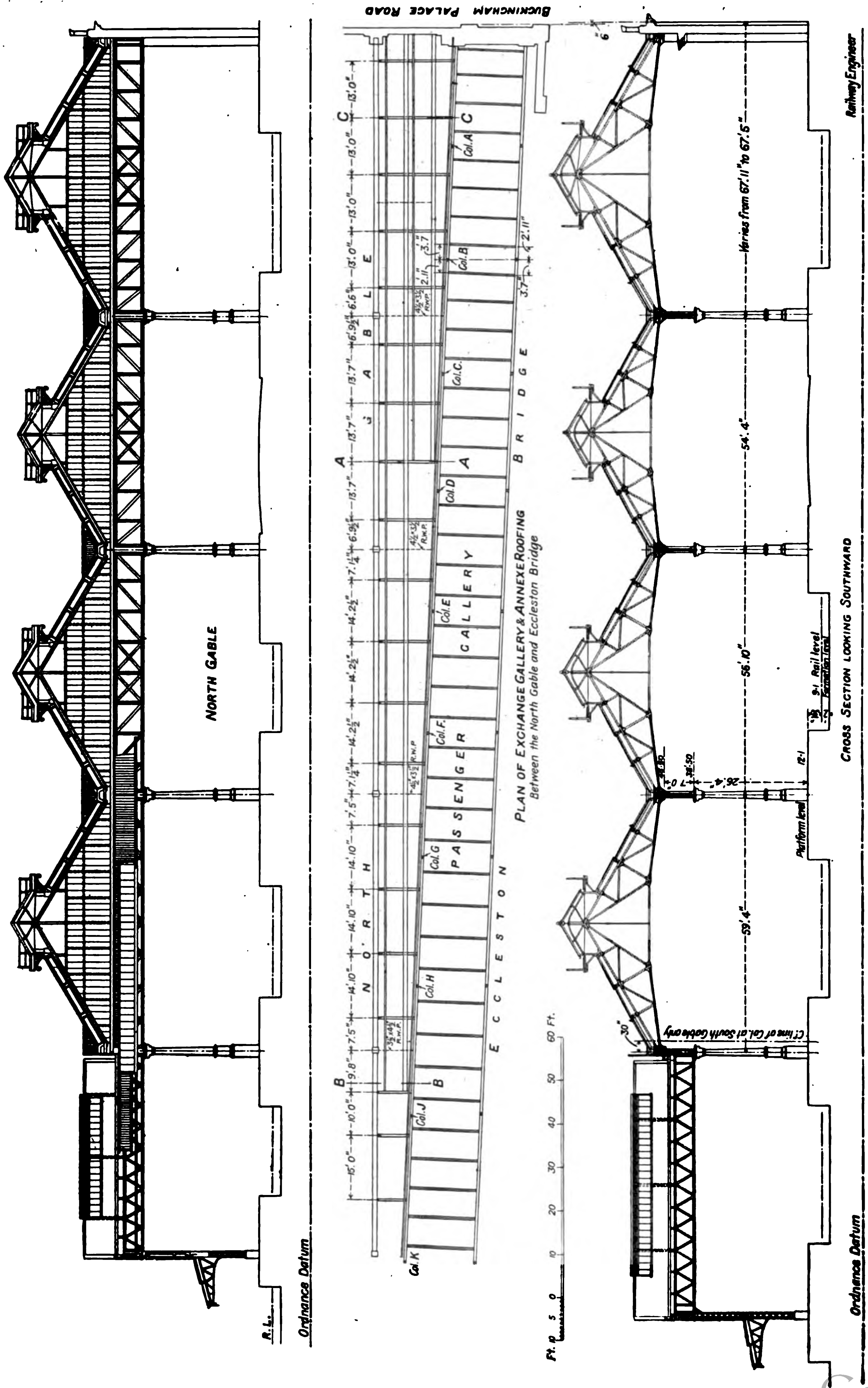
sessed when leaving the rolling mill. This almost incredible result is due to a chemical action of the cement and probably to the formation of a protective coating of silicate of iron. Concrete also resists equally well the effects of corrosive fumes and liquids which are feebly acid. It may be used for marine works if the proportion of cement employed be high.

4. The ease with which the material may be made to take

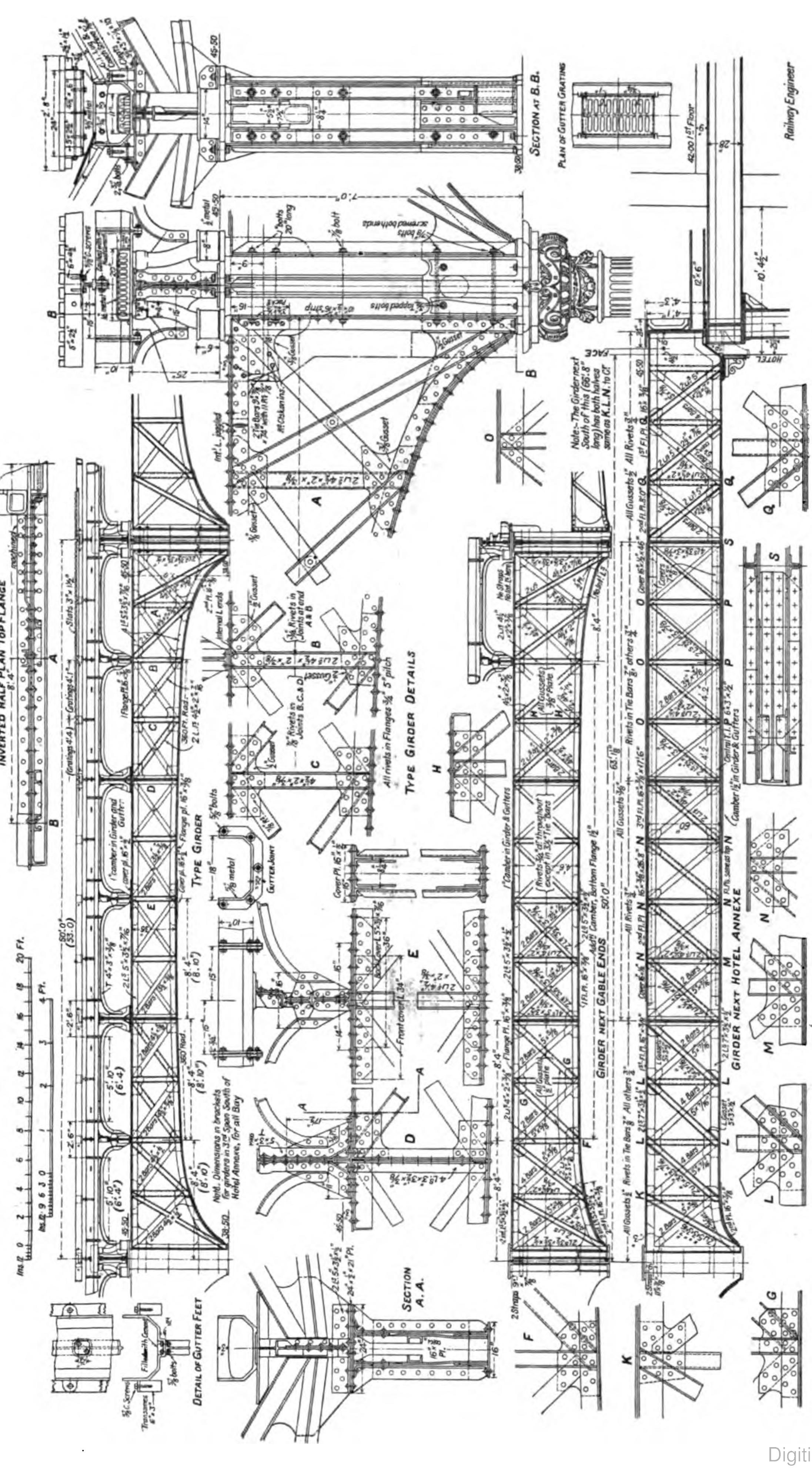
* Read before the Institution of Mechanical Engineers at Liége June, 1905.



Plan showing roof covering, Victoria Station Widening, London, Brighton and South Coast Railway.



General Cross Sections (South Roof), Victoria Station Widening, London, Brighton and South Coast Railway.



Supporting Girders between Columns. Victoria Station Widening, London, Brighton and South Coast Railway.

any desired form. While preserving the architectural appearance of stone a boldness in construction may be attained which is impossible with the latter material. It is merely necessary to measure the materials precisely; an error can be corrected during construction and unforeseen details can be improvised. This adaptability is specially valuable in dealing with existing structures.

5. Its homogeneity, and the mutual support which neighbouring parts give in resisting concentrated loads. Joints are no longer weak places. Girders which cross pass through each other without a break. Monolithic constructions are rendered possible which are far more resisting than others to secondary stresses.

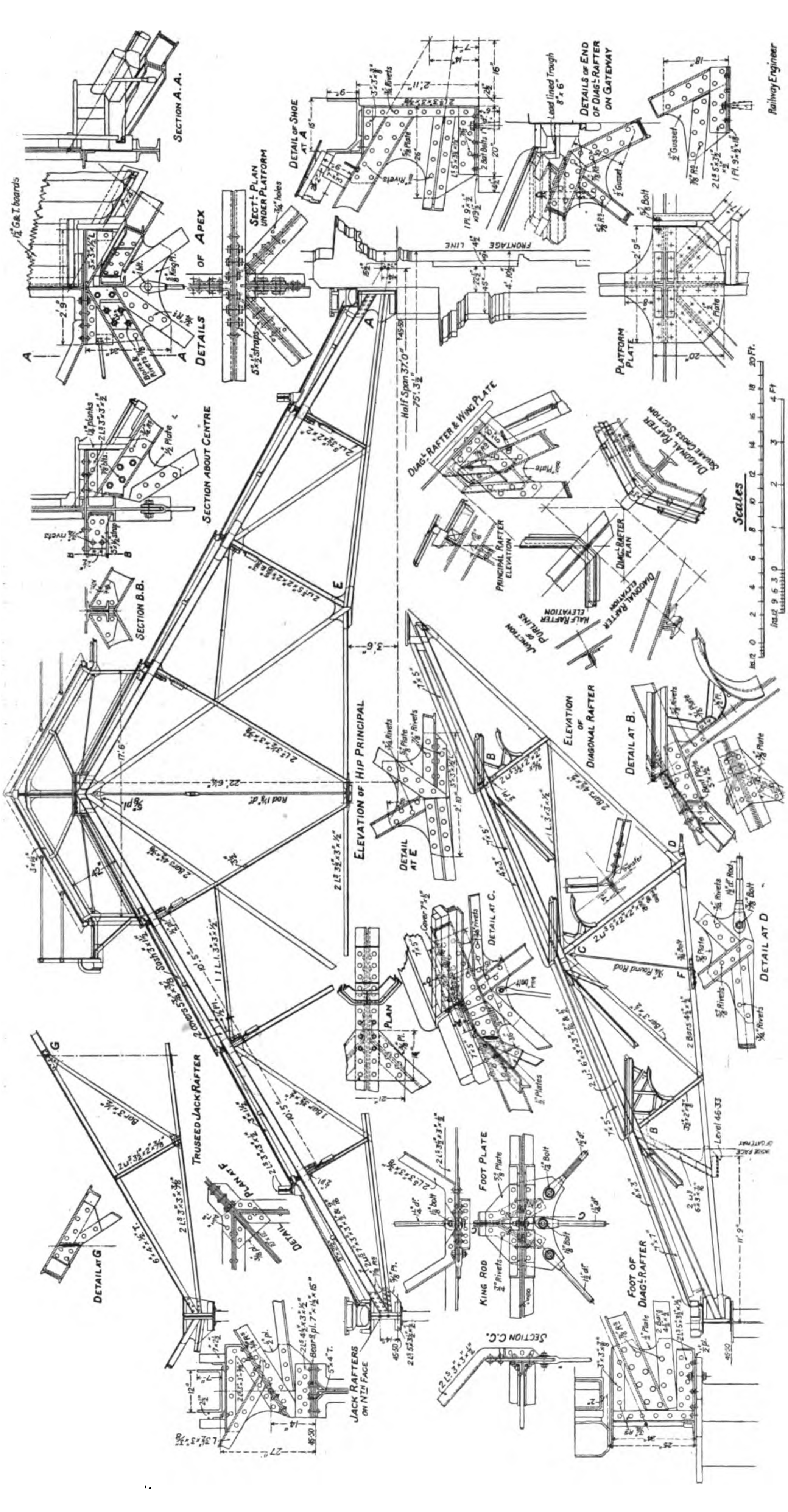
6. Its rapidity of execution. The constituent parts are merely raw materials requiring no previous preparation, and therefore procurable without delay. The individual importance of the single parts is negligible, thus rendering them easy to obtain, transport and erect. Night work also does not occasion the noise caused by riveting.

7. Its impermeability, if it has been "floated," immediately after construction in a careful manner. Under such conditions it may be used in the construction of flat roofs, reservoirs, sewers, etc. The monolithic structure which is also watertight may be produced without crack or re-entering angle, so that it can be freely washed down with the hose. Such a structure is essentially hygienic.

8. Its great rigidity and the localisation of the effects of shocks.

General Statements.

Concrete.—The material is an agglomerate of hard stones bound together with cement. As cement is expensive and contracts considerably it is of advantage to use the least possible quantity by reducing the volume of the voids between the pieces of stone. This result is obtained by using a mixture of materials of different sizes such as gravel and sand. Moreover, in order to disperse the cement with great certainty equally through the mass it should



Bay A. Hip Principal and Diagonal Rafter. Victoria Station Widening, London, Brighton and South Coast Railway.

be mixed with sand only. Instead of gravel, granite chips, the refuse of the quarries may be used with advantage. Although these chips cause more voids they nevertheless give a tougher product owing to their angular form, which increases the adherence. Granite dust may also be used instead of sand. The choice of cement is of the utmost importance, and in order to be quite certain it is desirable to use only Portland cement of a well-known brand.

According to the nature of the work the concrete contains from 350 lbs. to 700 lbs. per cubic yard.

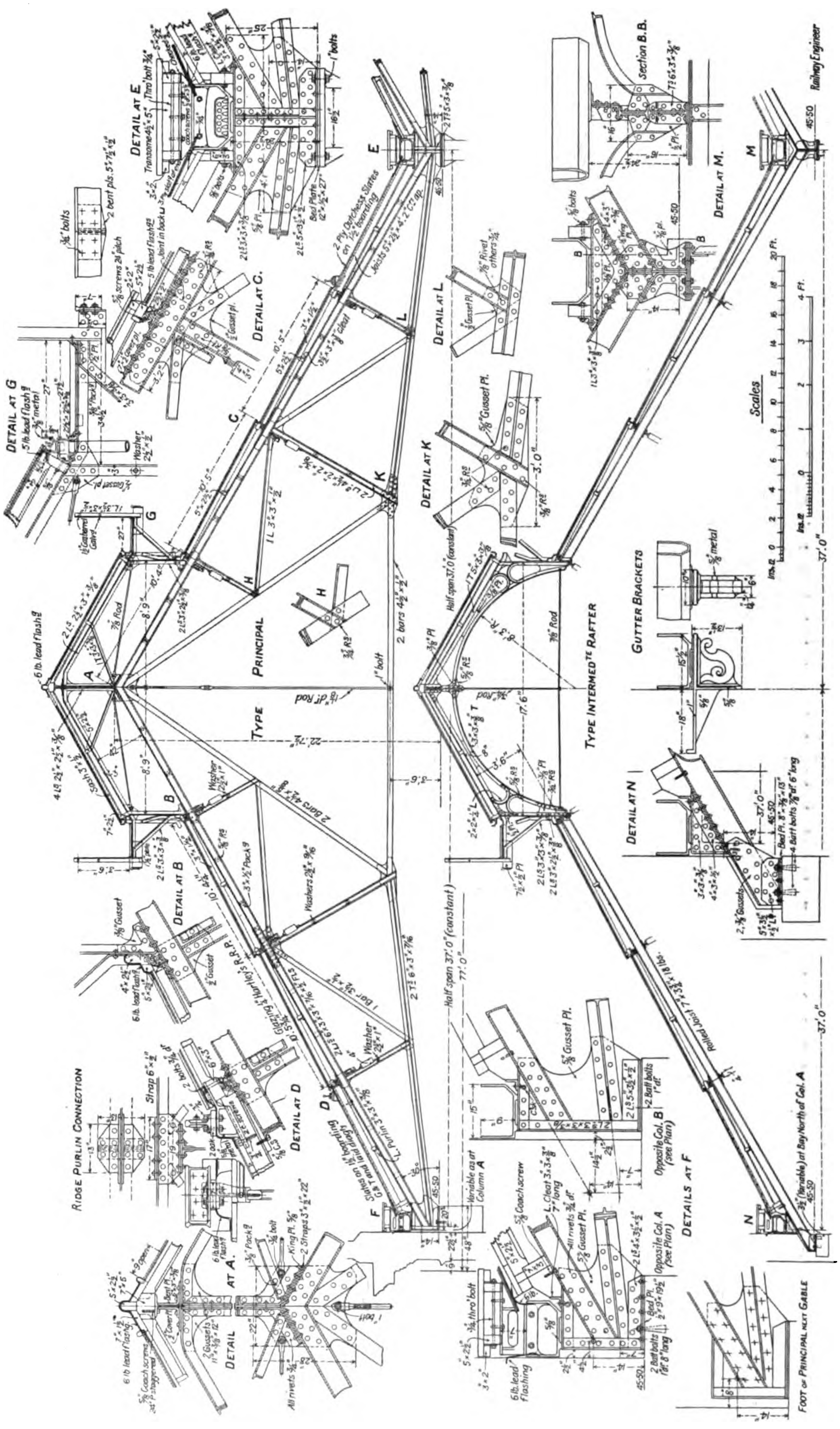
In systems of construction where the metal framework can carry by itself the whole load and where the concrete is merely intended to protect the metal, to fix it, and to hold its different parts together, then the quantity of cement may be reduced to the minimum, and the gravel may be replaced by slag or by coke breeze.

The concrete is far weaker than the other, but it is less expensive, lighter, more refractory and more sound proof, and nails can be driven into it.

Metal.—At the present time the metal almost exclusively employed is mild steel with an ultimate tensile strength of 27 tons per square inch. This costs no more than iron, and has the advantage of possessing a greater tensile strength and a higher coefficient of elasticity than the latter metal.

Round bars are generally used, as they facilitate the escape of air and the proper ramming of the concrete; they also possess no sharp angles which would cut the concrete, but, on the other hand, the round section gives the lowest coefficient of adhesion for a given cross section of metal.

Centering.—The construction of the centering is the most important part in the employment of structures in ferro-concrete. It takes up the most time, and seriously enhances the cost of the work. In the design of the centering the contractor has an opportunity to exercise all his ingenuity; to use wood which can be again employed, and to avoid cutting



Type Principal and Intermediate Rafter of Bays A. E. & F. West and East Bays, North of Eccleston Bridge. Victoria Station Widening, London, Brighton and South Coast Railway.

the wood into short lengths and so causing waste of material. If vaulted forms have to be constructed the cost of the centering may be greater than that of the ferro-concrete itself.

Certain systems reduce or even obviate altogether the use of centering by the employment of metal work of sufficient strength or pieces of concrete specially made for the purpose. Mouldings as a rule are roughly formed in the concrete by centering, and then finished in gauged work; but the latter is a difficult process, for the neat cement takes some time to set and is not sufficiently plastic.

Deflection.—It is not possible by a simple examination to ascertain the strength of a finished structure in ferro-concrete, for the metallic members are no longer visible and their precise size and position cannot be gauged.

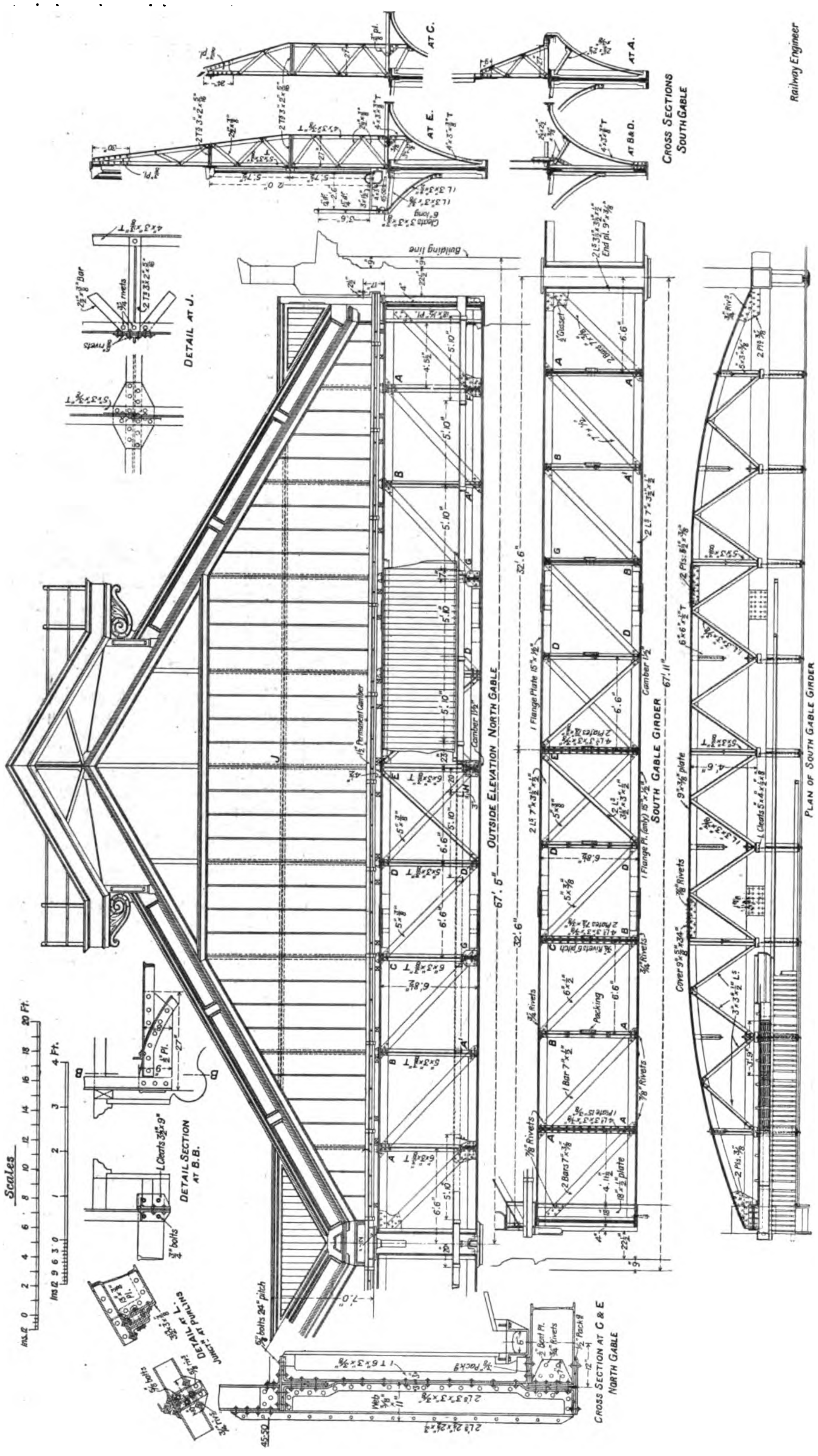
The only method is to measure the deflection of the structure under given loads. The results obtained are, however, not precise, and useful information can only be gained by comparing similar structures. The deflections of structures in ferro-concrete are much less than those which would be given by a structure of equal strength built of wrought iron, for when concrete is stressed up to its elastic limit its deflection is less than that of iron under similar conditions.

Principles of Construction.—Professor Rabut has summed up in the following six rules the principles which experience and theory recommend should be followed in the construction of ferro-concrete buildings :—

1. No connections should be made of iron to iron, as the concrete itself holds the parts together in the most economical manner.

2. At least two distinct haud, the round section should be used, the one system to take up the tensile stress, and the other to take up the shearing stresses in the concrete; when it is necessary a third system should be used to take up the compressive stresses.

3. To so arrange the reinforcement that the separate members may be stressed



Bay F. North and South Gables. Victoria Station Widening, London, Brighton and South Coast Railway.

in the direction of their length, so that the stresses produced between the iron and the concrete shall be tangential and not normal to the axis of the members of the re-inforcement.

4. To profit by all means of increasing the homogeneity of the various parts of the structure. This may be done by prolonging the iron parts of one portion of the structure into the thickness of the concrete of the adjoining portions, at a negligible cost; while the construction of rigid joints in a metallic structure is very expensive.

5. On the other hand, advantage should be taken to the utmost extent of the homogeneity thus obtained to economise materials.

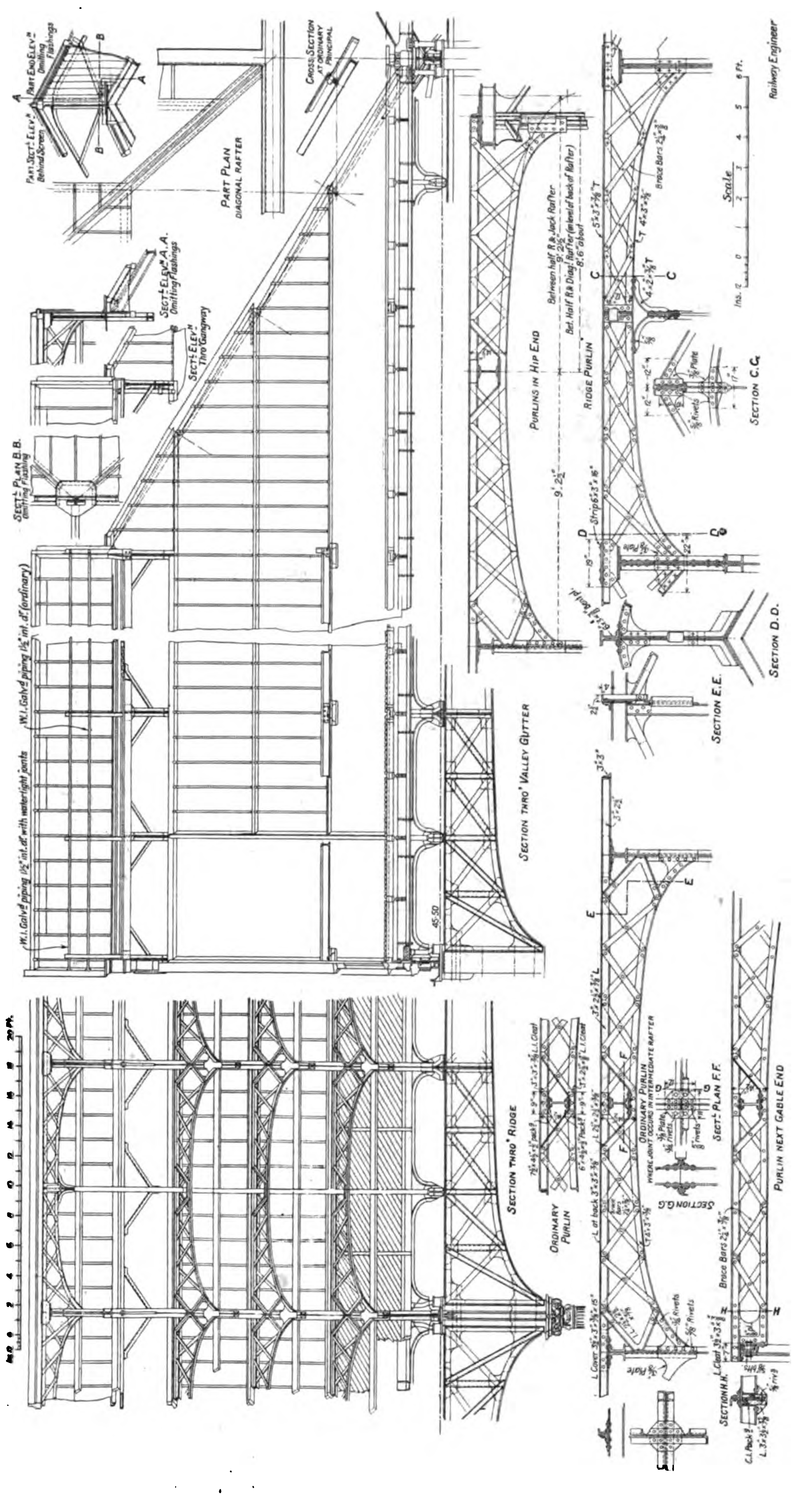
6. In view of this homogeneity sudden alterations in the cross section of the parts should be avoided, as the parts tend to assist one another and to distribute the stresses, the constitution of ferro-concrete being, so to speak, democratic.

The component parts of a ferro-concrete structure may be classed under three headings, which the author will examine in turn. They are (1) the parts which resist tensile stresses; (2) those which resist compressive stresses; and (3) those which resist more complex stresses.

Parts Resisting Bending Stresses.

These comprise chiefly the beams and the platform beams. In the majority of cases the beam supports a platform which is solid with it, and can therefore be used as a framework in compression; and this is one of the most characteristic properties of ferro-concrete. The beam is therefore really composed of the rib and the part of the platform on each side, and this has a cross section in the form of **a T**. The tension member consists of one or of several metal bars embedded in the lower part of the rib.

The materials are therefore used in the most rational manner, the concrete of the platform is subject to compression and the metal resists tension; but this specialisation of work is only possible owing to the adhesion of the concrete to the metal. In reality there are forces tending to pro-



Longitudinal Sections through Ridge and Valley Gutter, Bay A; and Purlin Details. Victoria Station Widening, London, Brighton and South Coast Railway.

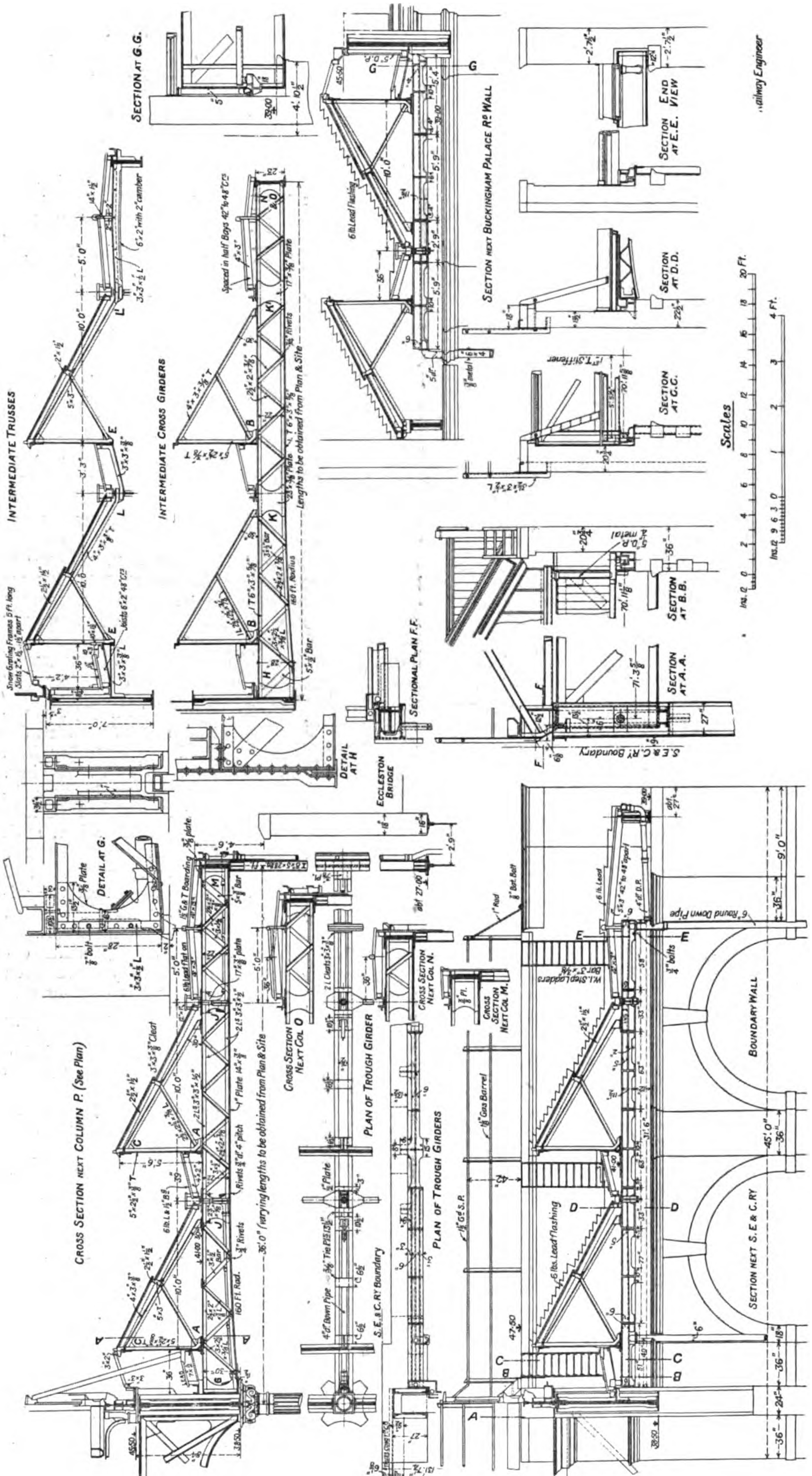
duce sliding, and these are proportional to the shearing forces, and therefore attain their maximum value near the supports. These forces tend to shear the concrete of the rib, and are concentrated at the contact surface of the concrete and metal. The mutual adhesion of these two materials has a very great importance, and it is well to bear this in mind.

Numerous tests have shown that in a carefully built structure this adhesion is not of lower value than the shearing coefficient of the concrete itself. If, however, the concrete be very poor in cement, or if it has been gauged too dry and insufficiently rammed, then the adhesion may be low and the use of bars of special section has advantages, these bars having projections which prevent all slipping of the metal in its concrete sheath. Such bars are very commonly used in American practice.

It has been stated that the adhesion was illusory, and that in reality the effect was merely due to a high coefficient of friction between the iron and the concrete which compressed it in shrinking. But the fact that beams subject for lengthened periods to incessant vibration, such as those in the floors of flour mills, have remained sound tends to prove that the adhesion is real and lasting. Special tests have always given reassuring results, except when they have been made upon flat contact surfaces; but this is a condition which does not occur in practice, and it is probable that during setting the contraction of the cement produces tangential stresses which destroy adhesion as it is produced. In the case of cylindrical surfaces, on the contrary, this contraction produces compression normal to the axis of the cylinder and therefore favourable.

Adhesion does not only assist in resistance to shearing stresses, but the variations in relative volumes of the two materials in contact must be considered; these variations being caused by change of temperature or by shrinkage of the concrete.

Temperature has no influence, for the coefficients of



Weaver Roofing, next Eccleston Bridge, North Station. Victoria Station Widening, London, Brighton and South Coast Railway.

expansion of iron and concrete are practically the same. When concrete sets in air it contracts, and therefore may produce considerable initial compression upon the embedded metal whilst being itself subject to an equivalent tensile stress.

When the concrete sets under water the opposite effect is produced, the concrete expands and puts the metal in tension.

It is important that the shearing strees should neither overcome the adhesion of the metal to the concrete nor shear the rib of the beam.

To fulfil the first condition it is necessary to form the metal framework of such a number of bars that their surfaces in contact with the concrete shall be large enough, and in consequence the chance of surface slips shall be reduced. To avoid shearing of the rib special stirrup-shaped bars are used which join together the two members. It is not correct to state that these stirrups directly resist the shearing stress. In reality, a piece which is under shearing stress throughout its entire length is by that stress subject to bending, but the stirrups have no rigidity and are incapable of resisting any appreciable bending moment; as a matter of fact, they fulfil the same purpose as the tension bars in the web of a lattice girder; the duty of the compression bars is fulfilled by the concrete of the rib. It is therefore obvious that it is essential for the stirrups to be hooked at one end to the tension bar, and that at the other end they should be solidly imbedded in the concrete platform. Fig. 1 shows the transverse section of a beam built on the Hennebique system and beside it the drawing of a single stirrup. This stirrup consists of a flat bent bar with the two ends bent in the form of claws, allowing it to hook itself solidly into the floor structure. The use of the flat bar in preference to the round bar facilitates the construction. Fig. 2 represents a cross section of a beam on the Coignet system. Here there is an upper iron framework. Owing to this it is possible to put the framework of

a beam together in advance and to place it in position entire while holding it by the upper bar. The attachments are made of bars of round iron bent to U section, and the ends are twisted together so as to form an elongated ring. Owing to the presence of the two frameworks the attachment binds the two members together very effectively. The round section is better suited to the concrete than the rectangular form.

Another means of resisting sliding consists in omitting horizontal bars in tension, and substituting bars fixed obliquely in the webs and rising to the floor structure at the ends of the beam. In this manner a beam of variable height is obtained approaching more or less closely to the parabolic form, that is to say, the ironwork will be subject to a constant tension upon its entire length, and the shearing stress will be zero, as it is neutralised by the vertical component of the oblique tension in the bar.

(To be Continued.)

Cape of Good Hope Government Railways, 1904.

As it has been decided that the reports upon the working of the Cape Government Railways shall coincide with the financial year —1st July-30th June—the general manager, Mr. T. S. McEwen, has made a report covering the operation of the railways during the first six months of 1904, and which states that:—

The capital as at the 30th June, 1904, was £26,453,855 against £24,945.974 as to the 31st December, 1903.

The financial results were:—

Total Earnings.	1904. Half-Year.	1903. Full-Year.
	£	£
Passengers and Parcels ...	732,710	1,631,001
Goods and Minerals ...	1,299,681	3,299,738
Vehicles, Horses and Dogs	23,333	68,613
Livestock	38,040	127,069
Mails	18,018	30,724
Telegraphs, Miscellaneous...	30,770	61,213
Cartage	47,314	105,083
Hire of Rolling Stock ...	9,477	6,427
Total	2,199,343	5,329,868
Total Expenditure ...	2,050,999	4,522,590
Credit balance ...	148,344	807,278
Interest on capital expenditure at £3 14s. per cent. per annum	486,722	923,001
Balance	338,378	115,723
The net earnings per cent. ...	£1 2s. 7d.	£3 4s. 9d.
Decreased percentage ...		£2 2s. 2d.

The total train miles were for the half-year 5,476,281, as against 12,701,077 for 1903; the earnings per train mile being 8s. 0·4d. and 8s. 4·7d. and the expenditure per train mile 7s. 5·9d. and 7s. 1·5d. respectively, thus showing a decrease in earnings per train mile of 4·3 per cent. and an increase of expenditure of 5·1 per cent.

The gross revenue amounted to £2,199,343 for the half-year, being at a considerably lower average than the receipts for the year, 1903, viz.: £5,329,868.

The only items worthy of note are, that while in second and third-class passenger traffic the receipts have dropped 13·8 per cent. and 12·8 per cent. respectively, the first-class has only decreased by 2·6 per cent., and in goods traffic while imported grain has been reduced 52·5 per cent., South African grain has, on the other hand, shown the remarkable increase of 104·8 per cent.

The falling-off in through traffic with the Orange River Colony and Transvaal has been very great, the value of the same to this Administration for the six months being only £631,611 as compared with £1,708,126 for the previous year. This is mainly attributable to a shrinkage of trade, although the diversion of traffic to Delagoa Bay has undoubtedly decreased the volume dealt with at Cape Ports. No sudden or considerable increase of revenue is anticipated, but a steady improvement, as the result of the ameliorated labour conditions in the Transvaal, admitting of a large increase in the number of stamps at work, and the replacement of surplus stocks, which must be nearing exhaustion, is hoped for.

It was not until after the close of the period under review that the Government took decided action in the direction indicated in the last report as being necessary to equalise revenue and expenditure, viz.:—(*a*) Reverting in local traffic to the goods rates which were in operation prior to June, 1903; (*b*) withdrawing the 8½ per cent. temporary allowance to daily paid men; (*c*) deducting, temporarily, from the salaries of officers an amount equal to half the special increase granted by Parliament for the financial year 1903-04; and it is strongly recommended that the position taken up in respect of local rates in September last, and of wages in October last, be adhered to until the financial results warrant greater facilities being granted to the public and increased emoluments to employes. The slightly increased revenue per month since the beginning of October, and the reduction in working expenses have placed the railway finances on a comparatively satisfactory footing.

The unremunerative character of the branch lines working may be gathered from the facts that 1,074 miles of branch lines (out of a total mileage open of 2,562) were worked at a loss of £4,309, or, including interest on capital outlay, of £180,439, or more than half the total deficit.

Comparing the expenditure with the work done it appears excessive, and to a certain extent this is the case, as the heavy fall in revenue could not be met by immediate curtailment of works; moreover, the Government policy of retaining a large surplus staff was of course disastrous from a railway point of view, although beneficent and fully justified as a national measure against adding to the large number of unemployed in South Africa.

The sum expended on relaying and regrading and on redemption of rolling stock has been at practically the same rate as during the previous year, and when applied to the average rate per train mile upon a considerably reduced mileage has the effect of increasing the average cost. These exceptional charges to revenue represent no less than 11·6 per cent. of the entire working expenditure, or, in other words, add 10·4 pence to the cost per mile. The details of the expenditure per train-mile are as under:—

	1904 Half-year.			1903 Full-year.	
	s.	d.		s.	d.
Maintenance, way and works ...	1	2·0	...	1	0·8
New works...	0	1·3	...	0	1·6
Relaying and regrading	0	4·9	...	0	4·1
Locomotive charges	2	5·2	...	2	7·0
Carriages and wagons (repairs and renewals)	0	8·1	...	0	7 0
Additional rolling stock, workshops, steamsheds, &c....	0	5·5	...	0	4·8
Traffic expenses	1	7·1	...	1	4·9
Compensation	0	1·5	...	0	1·4
Cartage	0	1·9	...	0	1·8
General charges	0	2·0	...	0	1·5
Harbour tonnage allowance ...	0	1·0	...	0	1·3
Telegraph maintenance	0	0·5	...	0	0·4
Schools	0	0·1	...	0	0·2
Sick fund	0	0·8	...	0	0·7
	7	5·9		7	1·5

Every endeavour was made to reduce expenditure by gradually curtailing the outlay on extra works, and not filling up any vacancies which could possibly be avoided in the staff. Whilst this policy was not in accord with that recommended in the report for last year, from the railway point of view, there is no doubt that the action of the Government in not adopting a drastic retrenchment scheme greatly mitigated the hardship which would otherwise have been more severely felt, but with a financial result to the railways as indicated in this report.

Working and maintenance has been charged with £2,557,795 divided as follows:—Additional rolling stock, etc., £1,213,938; relaying and regrading, £742,041; new and additional works, £601,816; while in the corresponding previous six months only £316,829.

The figures given in the following statement show the comparative consumption and cost per train mile during 1903 and January to June, 1904:—

	1904 (Half-year) Consumption lbs.	per train mile d.	1903 Consumption lbs.	per train mile. d.
Western System:—				
Welsh Coal	68·59		66·24	
Welsh and Viljoen's Mxd.	63·94	10·57	67·97	13·01
Midland System:—				
Welsh and Viljoen's Mxd.	80·32	12·33	74·45	13·97
Eastern System:—				
Welsh, Stormberg and Viljoen's Mxd. ...	119·86	15·22	126·58	17·01
Indwe	125·07		122·31	

The mileage worked with the Welsh coal included a much larger proportion of light, shunting and other engine mileage to train mileage than was the case when mixed coal was used.

The satisfactory results obtained from borings for water have, in a measure, neutralised the effects of the continual drought. The quality of the water for locomotive purposes is not always as good as could be wished, and, where the consumption is large and the water deleterious in its action on the boiler tubes, arrangements have been made to make a trial of the Mirrlees Watson distilling plants. Three sets have been indented for, and one is now in use at Noblesfontein with satisfactory results.

To stimulate the production of Colonial wood sleepers, and to assist the wood-cutters of Knysna, who were represented to be in a deplorable state of poverty, the Department of Agriculture and this Department jointly agreed to offer a bonus of 5d. per sleeper for every 100 sleepers delivered, and it is anticipated that this will somewhat increase the supply, but, for many years, in fact until the forest plantations started by the Department in 1902 can be relied upon for a regular output of well-matured timber, we shall be almost wholly dependent upon the imported article.

During the half-year 26 fatal accidents as against 89 for the year 1903. On the suburban line the continued reduction in the number of accidents is very marked, the figures being 15 for the half-year January to June, 1904, as against 45 for the same period in 1903.

Tyer's Tablet Instruments are now in working on 46 sections of the line, and others are still being installed. The introduction of these instruments has resulted in a considerable saving in time in the crossing of trains, and at the same time greater safety is ensured.

During the half-year 46m. 72chs. of new railways were opened for traffic, but they have not had any marked effect on the revenue, and up to the 30th June, 1904, they had not paid their working expenses.

The construction of these lines may possibly be justified from the point of view of developing the resources of the country, but from the railway standpoint, financially speaking, they will prove a heavy charge on the revenue. This will also apply to several lines now under construction.

With the policy of extending the advantages of railway communication when it can be justified, Mr. McEwen is entirely in sympathy, and, whilst strongly recommending adherence to the 3ft. 6in. gauge, he is of opinion:—

(1) That such developing lines should be constructed in the first place as cheaply as possible, following more or less the surface of the ground, and finished so as to admit of trains being run at a speed of from 8 to 10 miles an hour;

(2) that the ratepayers of the district through which the line passes should guarantee to make up the loss, or a portion of the loss, on working. This proviso is suggested so as to prevent the reverting to ox-wagon haulage after the line is built, as has been the case in several instances, and, where it has not actually been put into practice, the suggestion has been made so as to induce the Department to reduce its rates;

(3) that the line should not be fenced;

(4) that a developing line shall not be constructed unless land for stations, sidings and all other railway purposes be granted free together with the right to bore or sink for water, which can be taken without charge.

It is very soon forgotten how much the land is increased in value by the construction of a railway, which in many cases is followed by a strenuous effort being made to make the department pay up in every possible way. It is also as well to point

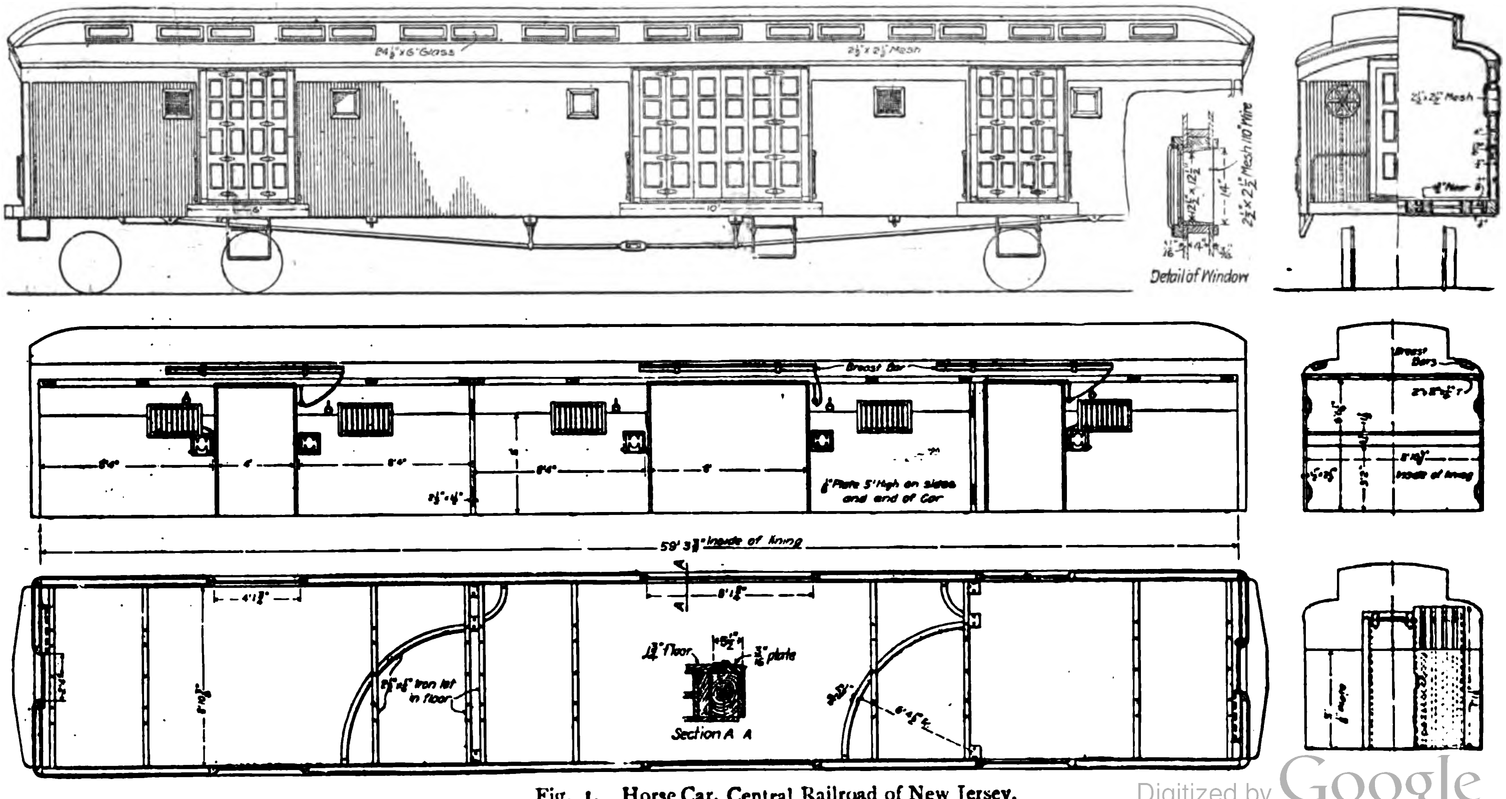


Fig. 1. Horse Car, Central Railroad of New Jersey.

out that before the opening of a line the rates are generally abont 300 per cent. above what they are even at developing railway rates.

In other countries a grant of land is made to the company who construct a line such as indicated, so that the latter may share in the appreciation in values later on, but this may not be considered feasible when Government takes the work in hand.

Conditions on the lines indicated would lead to many more railways being made, as the general taxpayer would recognise the fact that every effort had been made to protect his interests, which are virtually the interests of the country.

The catering has now been performed by the Department for about 18 months, and it is satisfactory to find that the experiment has proved a success, in so far as it has tended to increase the comfort of the travelling public, at comparatively speaking a slight monetary loss on the six months' working. This, however, may be due in a great measure to the general depression, and will disappear when times improve, although, with the restrictions imposed on the Department by the Government in the conduct of its catering business, a large profit can never be expected.

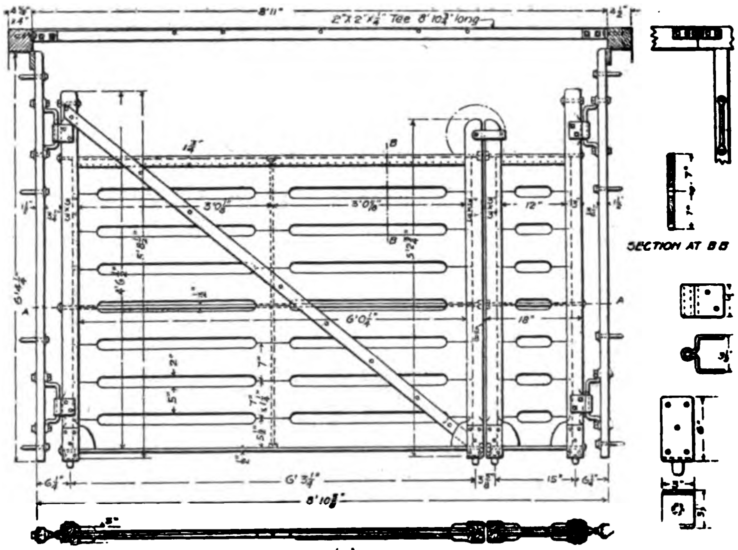


Fig. 3 Transverse Stall Partition, Horse Car, Central R R. of N. J.

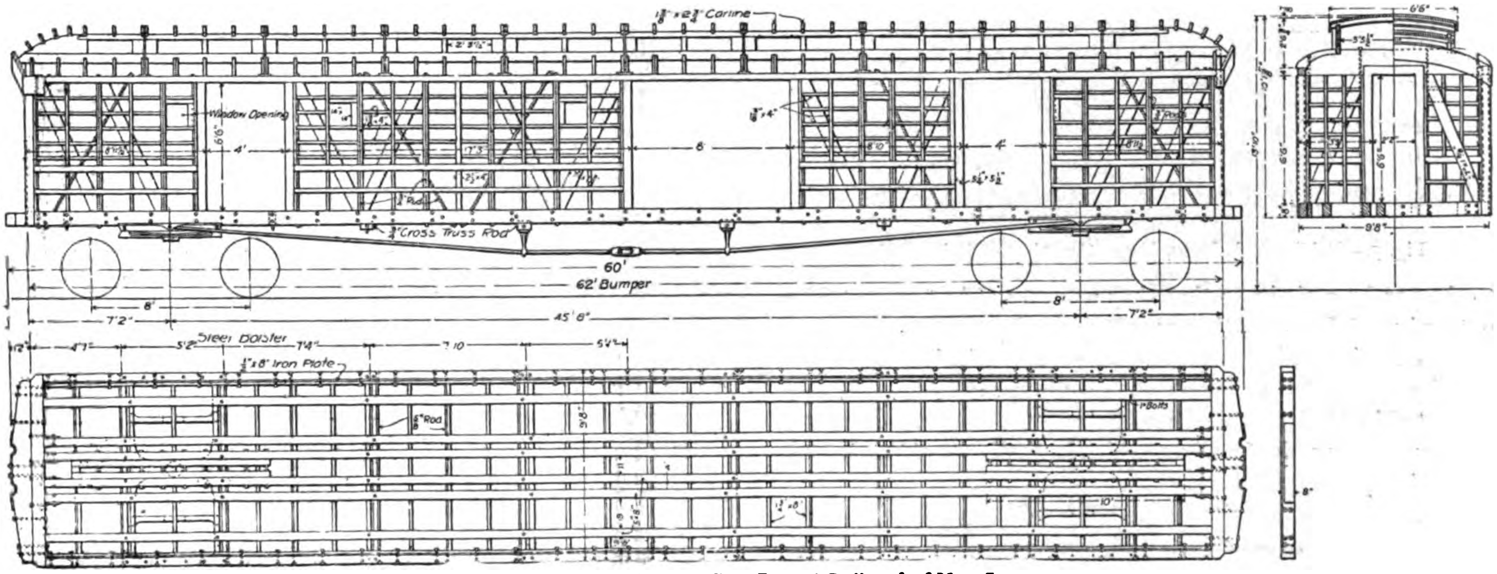


Fig. 2. Framing of Horse Car, Central Railroad of New Jersey.

60 ft. Horse Cars.

The Central R. R. of New Jersey has recently built at their works at Elizabeth port to the designs of Mr. Peter McIntosh, superintendent of motive power, some large and well-arranged cars which can be used either for baggage or for the transport of horses. They are particularly intended for dealing with "rushes" of horse traffic which occur at certain seasons of the year. It will at once be noticed that the divisions and stall partitions are not padded with the care which is customary in this country. When the car is being used for baggage the divisions are swung back against the side of the car. Fig. 1 shows the plan and elevation of the car, which has three doors on each side. The car is divided into five compartments by means of the cross partitions, fig. 3, which are really two gates hinged to the sides of the car. The narrow one is for the attendants to pass through. These gates lift on their hinges and are stepped into the floor. Iron tracks are let into the floor for the divisions to travel on.

There are two divisions which enable 5 rows of horses to be stalled with their heads facing the spaces between the side doors of the car.

The stall partitions, fig. 4, between the horses are slung by iron straps from T irons which stretch across the car between

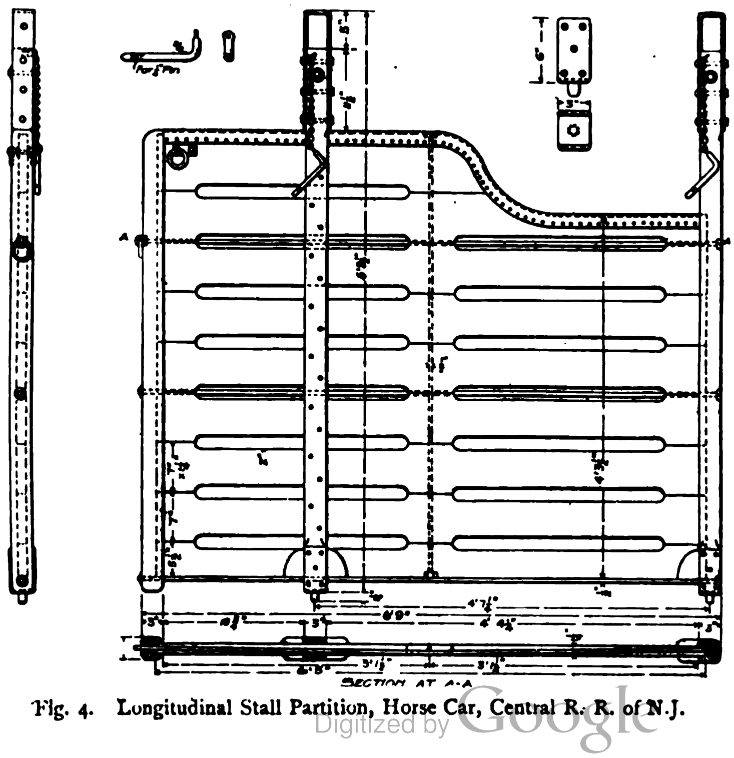


Fig. 4. Longitudinal Stall Partition, Horse Car, Central R. R. of N.J.

the cant rails, and which is a permanent fitting. These T irons have holes so that the stall partitions may be secured by pins in positions suitable for from one to four horses.

In order not to reduce the width of the car sliding side doors were not fitted, but hinged folding doors (as shown by fig. 5) secured by bolts.

The stalls are closed by breast bars which, when not in use, are carried in pockets on the roof (inside). They are secured

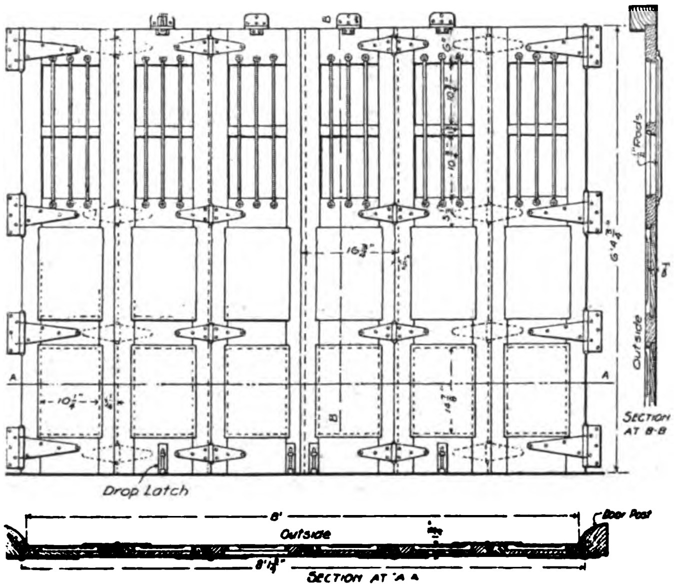


Fig. 5.—Folding Side Door, Horse Car, Central R.R. of N.J.

to the car by a chain so that they cannot get lost or be taken out and used for any other purpose.

The car is ventilated by 5 windows on each side, protected by wire gauze and provided with a glazed sliding sash, and protected inside by vertical iron bars.

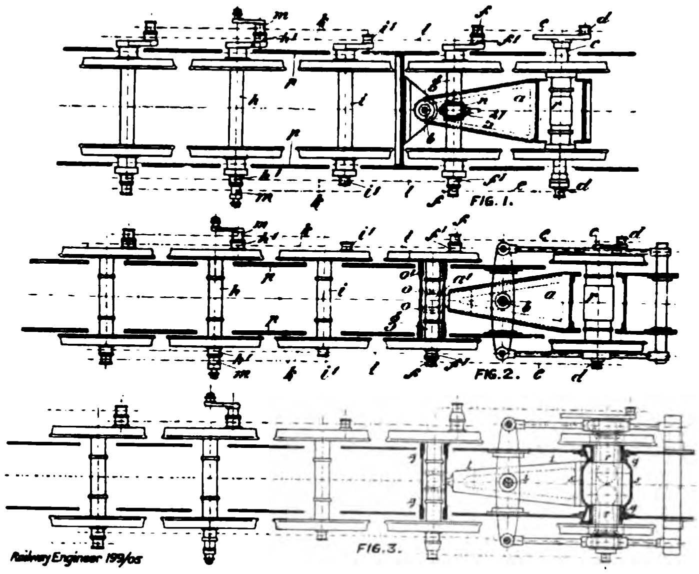
Fig. 2 shows the framing, which is similar to that adopted for ordinary baggage cars.

The car has a capacity for 20 horses.

Recent Patents relating to Railways.

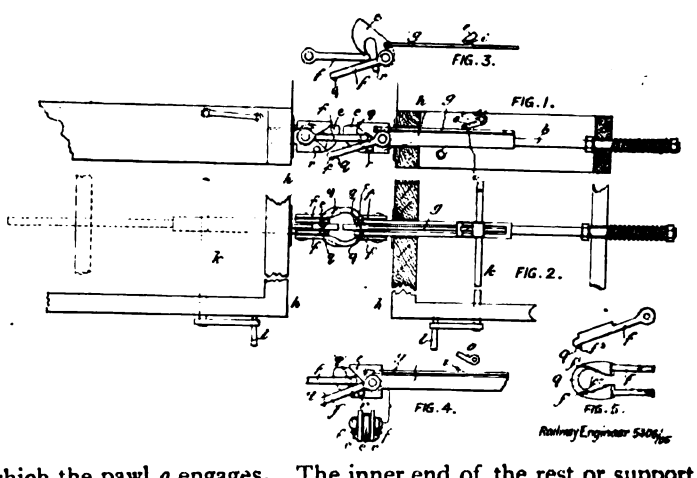
THESE abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d*. each.

Locomotives. *199. 4th January, 1905. C. Hagans, 40, Karthauserstrasse, Erfust, Germany.*
The bogie frame *a* is pivoted to the main frame *p* at the point *b*. and is guided by the hollow axle or hub *r*. In this hollow axle is arranged the core axle *c* supported in the main frame, with its coupling pins *d* driven from the coupling pins *f* of a coupled or driving axle *g* by means of coupling rods *e*. The axle *g*, if it be a coupled axle, as in the constructions illustrated, is either driven direct from a driving axle *h*, or through a coupling axle *i* by means of coupling pins h^1 h^1 and coupling rods *k* acting on the pins f^1 of the axle *g* through coupling rods *l*. In the latter case, *m m* are the cranks driven from the cylinder. The end axle constituted by the hollow axle *r* and the core axle *c* moves the axle *g* laterally by means of the bogie frame *a*. The core axles *c* are either not movable laterally, or only movable in rectilinear direction to a very small extent, or are laterally movable, in case of large bends, in a circle having a radius equal to the length of the coupling rods. The movement of the coupling or driving axles *g* is in most cases so small that the clearance in the axle bearings and coupling pin bearings of the coupling rods *k* and *l* is sufficient to equalise the length alterations of the coupling rods *l* produced by small deviations of the axle *g*. In the construction shown in figure 1, the axle *g*, coupled to the coupling axle *c*, of the bogie *a*, is arranged in the main frame between the axle *c* and the pivot *b* of the bogie. It is provided with neck bearings g^1 enclosed by a bearing *n* on the bogie *a*. The deviation of the bogie *a* is transmitted by the bearing *n* to the agle *g*. The movement of the axle *g* takes place, therefore, in the construction shown in figure 1, in the same direction in which the bogie is turned. In the construction shown in figure 2 the bogie is extended beyond its pivot *b*, and carries a claw or head a^1,



engaging between collars or projections *o* in the axle bar o^1 of the axle *g* coupled to the axle *c*. When the bogie *a* turns the axle *g* is therefore moved laterally about the pivot *b*, but in the opposite direction to the bogie. In the construction shown in figure 2 the core axle *c* instead of being supported in the frame *p*, as illustrated in fig. 1, is mounted in the well-known manner in a system of rods pivoted at one side to the main frame and guided on the other hand in a cross bar in the bogie. Instead of the bogie frames *a* Adam's axles or hollow axles *r*, mounted like Adam's axles, as shown in figure 3, may be used. (*Accepted 22nd June, 1905.*)

Couplings, Automatic. *5,406. 15th March, 1905. J. Darling, 8, Jedburgh Avenue, Rutherglen, Lanark.*
Relates to an improvement on the prior patent No. $3{,}277^{04}$. The rod *g* in the present invention runs along the upper side of the drawbar *b* and is provided with one projecting pin or tooth *i* with

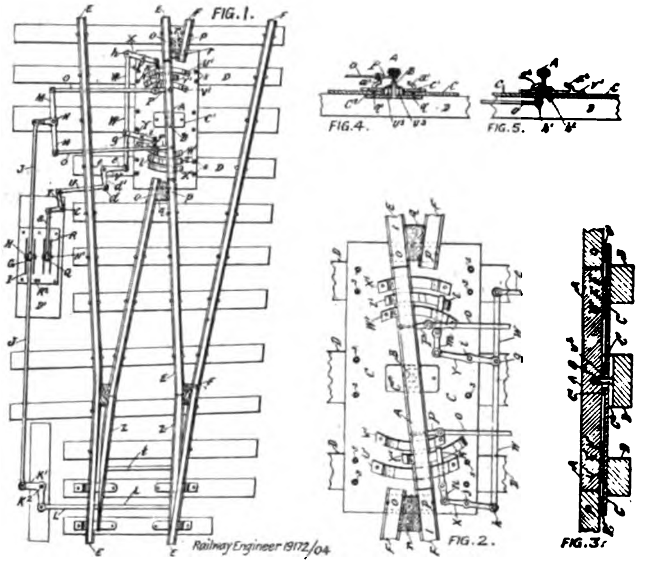


which the pawl *o* engages. The inner end of the rest or support *r* for the coupling links is slightly rounded or bevelled to ensure the links after an uncoupling is effected falling into proper position. The coupling links *f* are made slightly tapered towards their other end f^1; also slightly bevelled or angled laterally f^2 and are of square or flat section or surface, the underside of the outer end being provided with a toe-piece *q* slightly

bevelled or angled f^3 to engage with and run along the side of the lower link, and so act as a guide to the links in coupling. The mode of coupling is similar to that described in the prior patent, namely; when two waggons are brought together the coupling link *f* on one waggon comes in contact with the hook *e* on the opposite waggon, and the toe-piece *q* slipping over the front of the link engages with the side of it and so acts as a guide for the links in coupling. From the peculiar shape of the hook *e* the coupling link raises it until the point of it slightly projects beyond the end of the link, when the hook by its own weight falls, when it becomes engaged with the link and is held there and the coupling is thereby effected. When it is desired to uncouple the handle *l* on either side is slung or thrown over so that the pawl *o* engages with the pin or tooth *i* and so holds the rod *g* in a fixed position. The pull on the vehicle raises the hook *e* out of engagement with the link which then falls on to its rest or support *r*. (*Accepted 29th June, 1905*).

Crossings.—*19,172. 5th September, 1904. R. H. Pierce and G. D. Westropp, Rajputana-Malwa Railway, Ajmere, Rajputana, India.*

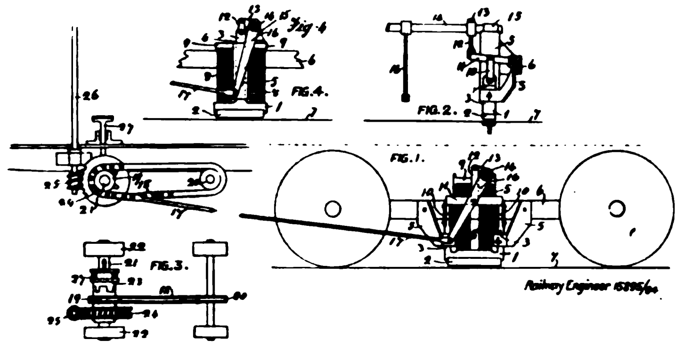
The crossing consists of a short length of a single rail A, centrally pivoted on a vertical pin B which passes through a substantial bed-plate C and which pin is securely fixed in an under plate C^2 countersunk in a central sleeper, the bedplate being securely fixed to the sleepers D. The pivot-rail working on its vertical pivot pin B is moved so that its ends are made to coincide and abut against the main line rail E or the siding rail F upon whichever it may be desired to transfer the train, by operating the shunting points and pivot-rail simultaneously with the switching apparatus and locking the same when in position. The switching



gear consists of lever G working on its pin H in casing I which actuates rod J, bell crank K^1 working on its angle pin K^2 actuating points rail Z through points rod L, the forward end of lever rod J being connected to the double bell crank M swivelling on its centre pin N, which actuates tension ties O pinned to the outer ends of links P, the inner ends of which are connected to the pivot-rail A. The locking gear comprises a lever Q, bell crank levers T, V, connecting rods S, U, W, and arms X, Y carrying locking bolts K*l* which engage with curved locking chairs U^1, V^1, or W^1, X^1. (*Accepted 22nd June, 1905.*)

Slipper Brakes. *15,895. 18th July, 1904. R. H. Wilkinson, 207, Windsor Road, Oldham, Lancaster.*

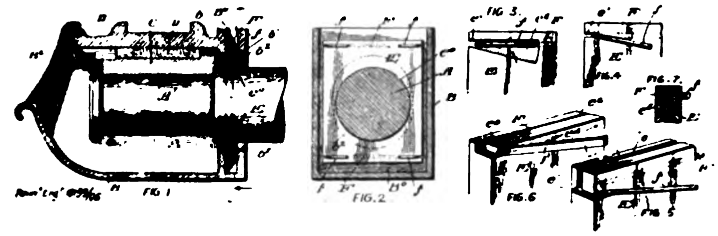
In a slipper brake for railway or tramway vehicles the shoes 1 are provided with arms 3, movable vertically in guides 4, and are pressed towards the rails by springs 8. The arms 3 are connected by rods 10 to a U-shaped lever 11 pivoted on the truck 6, and connected at its middle by rods 12 to arms 13 fixed on a transverse shaft 14. A long arm 16 on the shaft 14 is connected by a rod 17 to a pitch chain 18, passing round a toothed wheel 19 and an idle wheel 20. The wheel 19 is loosely mounted on a shaft 21, but can be locked to the shaft by a clutch 23. In order to raise the brake blocks a spindle 26, carrying a worm, and operated by a handle or wheel, is rotated, and acts through worm gear on the shaft 21, which rotates the wheel 19



and by means of the connecting rods and levers raises the arms 3 and blocks 2. When it is desired to apply the brake with full force instantly in an emergency the clutch 23 is disengaged from the wheel 19 by means of the foot lever 27, and the wheel 19 being then free to rotate on the shaft the pull on the connecting rod 17 is released, and the springs 8 instantly press down the blocks 2 with full force on the rails independently of the brake handle. (*Accepted 8th June, 1905.*)

Axle Boxes. *10,199. 15th May, 1905. J. S. Patten, 102, East Lexington Street, Baltimore City, Maryland, U.S.A.*

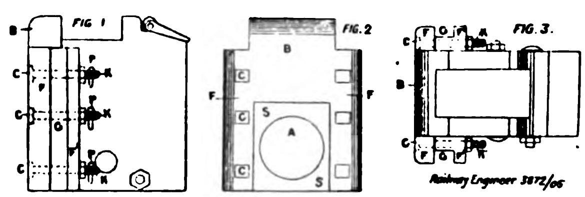
This invention consists in forming the dust guard of an axle box from a single board or plate provided with an aperture to fit the



axle, and fixing spring strips or wires in the board by bending their ends. The spring strips are arranged to bear against one side of the guard recess in the axle box and press the board or plate against the opposite side. (*Accepted 29th June, 1905.*)

Axle Boxes. *3,872. 24th February, 1905. H. Green, 24, Maesteg Road, Tondu, Brigend, Glamorganshire.*

Consists in constructing the axle box with a removable back B, which is secured by bolts K, and overlaps the body of the box at

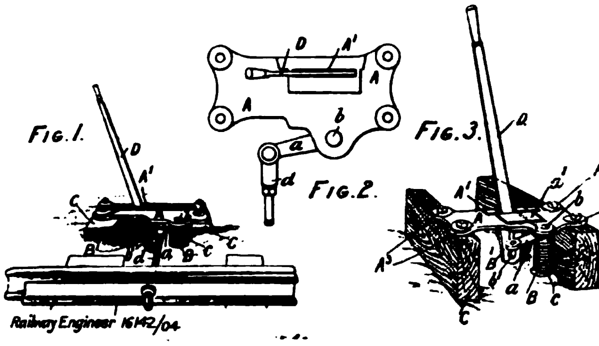


FF to form the inner sides of the guide channels. When the back is detached the axle box is freed from the guards and can be readily removed. (*Accepted 8th June, 1905.*)

Switch Point Levers. *16,142. 21st July, 1904. L. W. Williams and O. R. Williams, Railway Appliances Works, Cathcart, Renfrewshire.*

A bell crank lever *a*, a^1 is mounted on the upper part of a vertical pin *b*, the arm *a*, which is jointed to the switch connecting rod *d*, being acted upon by a strong helical spring coiled round the pin *b*. The box or housing frame A is mounted between parallel wooden or other planks C, to which it is bolted, and cast in one with it is an underhung bracket or casing B to receive the vertical pin *b* and helical spring *c*, and also a pocket chamber B^1, in which the operating handle or lever D is fulcrumed on a pin b^1,

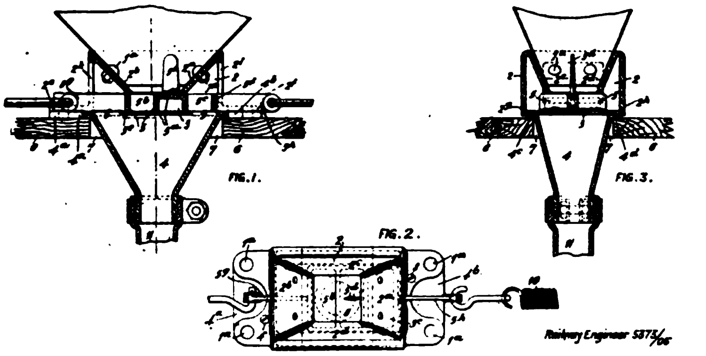
both the bracket B and pocket chamber B^1 being located below the surface or ground level. The handle D, when used to operate the bell crank lever a, a^1, acts on the free arm a^1 of the latter by moving through a slot A^1 in the housing frame A, and when the switches are run through trailing-ways the handle D



remains still, consequently the usual bumping and clatter is done away with, and the spring c instantaneously forces the switches back to their normal position. The cushioning action of the spring c preserves the adjustment of the connection and greatly reduces the wear of the switch blades. (*Accepted 8th June, 1905.*)

Sand Distributors. *5373. 14th March, 1905. S. Leech, 130, Park Road, Loughboro', Leicester.*

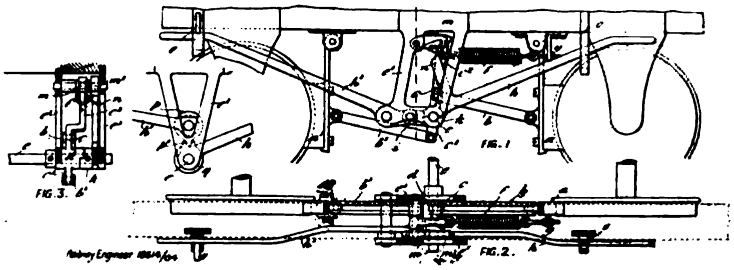
The sand distributing apparatus illustrated comprises a sand containing hopper 1, a combined hopper carrier and valve guide 2, a valve plate 3, a funnel 4, and a valve 5. The funnel 4 is rectangular in plan, and is provided along two of its edges with flanges 4^a, 4^b, that are of such a size as to rest upon the portion of the floor or frame plates 6 of the vehicle or engine that surrounds an opening 7, through which the funnel extends. The two edges of the funnel that are unprovided with flanges have recessed portions 4^c, 4^d. These recessed portions serve as a seat for the valve plate 3. This valve plate 3 is of a greater width than the funnel by an amount that is equal to the thickness of two of the walls of the combined hopper carrier and valve guide 2, but the plate is not of such a size as to cover the whole of the



top of the funnel when in position. Communication between the funnel and the interior of the combined hopper carrier and valve guide is possible, and as the valve plate 3 is arranged centrally, openings 8, 9 are formed between two of the sides of the plate and the adjacent portions of the funnel. The depth of the recesses 4^c, 4^d is such that the top of the valve plate when in position will be flush with the top of the funnel. The combined hopper carrier and valve guide 2 comprises a body having four vertically arranged walls that have at their upper ends inwardly and downwardly inclined flanges 2^a, 2^b, 2^c, 2^d that form an inverted truncated body. The valve 5 is provided with cells, such as 5^b, 5^c, which are alternately filled with sand and then brought over the openings 8, 9 to discharge into the funnel 4. (*Accepted 8th June, 1905.*)

Brakes (Wagons). *18,614. 27th August, 1904. J. Gouldie, The Gill, Brayton, Cumberland.*

This invention relates to an either-side brake, in which the operating levers are arranged to set and release a spring which presses the brake blocks on the wheels. The brake blocks a a^1 are connected by links b b^1 respectively with arms c c^1 extending upwardly and downwardly from a sleeve d which is loosely mounted on a transverse shaft e journalled in brackets e^1 under the waggon body. To an upward extension c^2 of the arm c is fastened one end of a spring f, the other end of which is adjustably secured to the waggon as by means of the bolt and nut attachment g. The spring f being under tension will apply the brakes when a detent is tripped by movement of the brake lever. Brake levers h h^1 are arranged to operate the transverse shaft e either by being keyed directly to h, or, being pivotted on a supporting bracket by means of a pin and slot connection i with an arm fixed to the shaft, which may be an extension of the fellow lever on the same side of the waggon. The spring f is set or released by any of the brake levers, a pin or clutch k keyed on the shaft e being arranged to engage the loose sleeve d so as to retract the brake blocks against the tension of the spring f when the brake lever is moved upwards to the off position. In this position the spring is held by a detent m which is pivotted on the



waggon frame and urged by gravity or a spring into engagement with the end of the arm c^2. When the brake lever is moved to apply the brakes the detent m is tripped by the engagement with it, or with a suitably shaped block m^1. of an arm n projecting upwardly from the shaft e or from the operating lever, thereby allowing the sleeve d to turn on the shaft e and the brake blocks to be urged against the wheels under the action of the spring f. A further downward movement of the brake lever increases the pressure of the brake blocks on the wheels by direct leverage, the clutch k being arranged to engage the sleeve d for this purpose, while preferably allowing a certain clearance or lost motion between the two positions of engagement to enable the brakes to be applied by the spring. (*Accepted 29th June, 1905.*)

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A.D. 1904.

10558. Railway signalling. Sykes.
13455. Coupling (automatic). De Castro.
13709. Automatic electrical signalling apparatus. Algernon Hamo Binton and Robert Percy Brousson.
14159. Signalling systems and apparatus therefor. Crossmann, Despons and British Pneumatic Railway Signal Co., Ltd.
14163. Moveable overhead frogs or switches for electric railways and tramways. Merz and Redman.
14200. Means of raising and lowering railway carriages and other sash windows and shutters. Williams.
14224. Train tablet and like systems of signalling on single line railways. McKenzie and Holland, Ltd., and Evans.
14368. Couplings (automatic). Ibbotson.
14792. Electric railways on the surface contract system. Rothwell.
15895. Brakes for railway or tramway vehicles. Wilkinson.
16110. Electro-magnetic mechanism particularly for use in railway signal apparatus. British Thomson-Houston Co., Ltd. (General Electric Co.)
16142. Levers for working switch points. Williams and Williams.
16853. Stopping place indicators for electric tramcars and the like. Wright.
17020. Emergency device for railway vehicle and like brake and controlling systems. British Thomson-Houston Co., Ltd. (General Electric Co.)
17632. Means for operating the points of electric tramways and the like, and also overhead points or trolley switches. Norris.
18226. Means for fastening railway carriage doors and other doors, Gilberthorpe.
18614. Brakes for trucks and other vehicles. Gouldie.
19172. Railway crossings. Pierce and Westropp.
27649. Rail-joints for collieries, quarries, light railways and the like. Bell.

A.D. 1905.

53. Automatically controlling the locks of railway carriage doors. Cartlidge and May.
199. Locomotives. Hagans.
1396. Rail ties or sleepers. Siferd.
1425. Rail joints. Lang.
1589. Electric train lighting systems. Union Electricitais-Ges.
1912. Electric railway system. Kinsman.
2289. Audible signalling apparatus. Kay.
2332. Car couplings. Janney.
3872. Axle boxes. Green.
4954. Simultaneous locking of doors of railway carriages. Dewhurst, Moore and Griffiths.
5373. Apparatus for distributing sand beneath the wheels of locomotive engines and other vehicles on railways and tramways. Leech.
5406. Couplings (automatic). Darling.
10199. Dust guards for axle boxes. Patten.

Mechanical Stokers for Locomotives.

At the recent convention of the American Master Mechanics' Association there was a topical discussion upon the use of mechanical stokers for locomotives. It should be read with interest by locomotive engineers in this country, where mechanical stoking for locomotives is not, to put it mildly, thought much of and where the experiments made so far have not been successful. In America mechanical firing for locomotives has become a necessity, but while that stage has not yet quite been reached it cannot be denied that there is much agitation for higher wages for working the large modern engines; firemen say that the physical labour cannot be done —" at the price," and this seems to be admitted by the fact that for many of the long fast non-stop runs the men are paid double or time and a half wages.

The " Victor " stoker referred to by Mr. Garstang was shown at the Railway Appliances Exhibition in connection with the recent International Railway Congress at Washington, and we are told it attracted considerable attention. Mr. Wm. Garstang, superintendent of motive power of the Cleveland, Cincinnati, Chicago and St. Louis R., who opened the discussion, is reported in the *American Engineer and Railroad Journal* as follows :—

" The question of a scientific method of firing locomotive engines is not of recent origin. It has always been uppermost in the minds of the management of railways, as is evidenced by the fact that some companies have offered prizes of various kinds for the most efficient and economical firing, and this, too, in the day of the small engine, whose grate area did not exceed 30 sq. ft., with a maximum steam pressure of 180lbs. If it was a question then, how much more important it must be to-day with 50 sq. ft. of grate area and a steam pressure of 200lbs. or more.

" Two hundred pounds of coal is an enormous quantity to burn per square foot of grate in an hour, but it can be done, and this would mean that with a grate having 30 sq. ft. of surface, the consumption of 3 tons an hour. This implies a shovel of coal every ten seconds, and we believe this is as much as the ordinary man can do. If we obtain, by compounding or superheating, more steam from 3 tons of coal, we have increased the capacity of the fireman, but who can say how long it will be before we must further increase the size of our engines and consequently the capacity of the fireman, the latter now admitted to be up to the limit.

" Ten years ago the most of us thought the maximum size of locomotives had been reached, when a spurt followed and the locomotive grew rapidly. Has the limit yet been reached? The engine having grown to such proportions in the past ten years, it is pertinent to ask, has the fireman also grown in that time? Experience says ' No.' An engine with 50 sq. ft. of grate surface, burning 200lbs. per hour per square foot, will consume 5 tons per hour, and if you get a fireman with sufficient physical endurance to handle 5 tons of coal per hour on an engine scheduled 45 (or 50) miles per hour, as they are to-day, he will very likely fall below the requisite in brain power, and, of course, be an inefficient fireman. This we all know from experience. So it seems our engines have passed the limit of human endurance in the matter of efficient firing.

"A young man thinks he would like to fire a locomotive; he makes application for the job; he goes with the foreman to look over an engine, and the enormous size of the boiler fills him with dismay, and he goes into some other business. This means that the work on the big engines is more of brawn than of brain. Some will say : ' That is all you need for a fireman.' But where are our drivers to come from? Surely they must be men of ' head,' now more than ever, when speeds are high and trains are heavy. This employment of ' coal heavers ' for the left-hand side of the engine will surely be felt before long on the right-hand side, when promotions must be made.

" They say : ' Necessity is the mother of invention.' It seems to have been so in this case. I presume someone, seeing farther ahead than most of us, thought : ' Why won't an automatic stoker work as well on a locomotive as on a stationary boiler?' To think was to act, and we now have a practical mechanical fireman that is going to revolutionise the grade of men who enter the firing service and eventually become engineers. Instead of the ' horny-handed son of toil,' with a back like a horse, who must work like a coal heaver for ten or twelve hours continuously, we will have a set of men of greater intelligence—men whose heads will guide the stoker and control it—men who will not sit idly in the engine cab by any means, but who, though busy, will not be continually 'frizzled' back of the open fire door, with their eyes blinded so that signals cannot be properly interpreted; but who, through intelligent operation of the stoker and careful watchfulness of the track and signals, and who coming in from a trip are not so tired out that they cannot study the rules and regulations and prepare themselves for advancement, will make a high grade of locomotive drivers when advanced to that position, and which will gradually mean a continuous elevation of both the men and the service.

" Now, as to the stoker in actual service. It has been four years since the first mechanical stoker was tested on a Big Four engine. About six months ago we installed a mechanical stoker, known as the ' Victor,' on seven of the largest passenger engines on our system. Four of these engines have wide fireboxes and three have the long, narrow firebox. Both styles of firebox have been fired satisfactorily by the Victor mechanical stoker. From advices we receive from the division officers, we can safely say there is a noticeable saving in the amount of coal consumed per car and engine mile when operated with the stoker in comparison with hand firing, but at this time we are not prepared to state the exact per cent. of such saving. The same advices indicate a reduction of boiler work, on flues, staybolts and firebox seams, which, in our opinion, is due to the fact that we are enabled to carry a lighter, cleaner and more uniform fire, as well as uniform boiler pressure.

" During the six months in which these stokers have been in service the cost of their maintenance has been very light. The principal cost of maintenance is largely due to improper lubrication. What few failures we have had with the stoker are due to the same cause.

" In conclusion, I will say it is my opinion the mechanical stoker for locomotives has come to stay.

First—Because it is practical and efficient.

Second—We believe, by the adoption of the mechanical stoker the railway companies will be enabled to use a cheaper grade of coal than can be used in hand firing, resulting in a great reduction in their fuel bills.

Third—It will relieve the fireman of some of his most arduous labour and give him greater opportunity to observe signals while on duty, and he will arrive at the end of his run in condition to improve his chances by study for promotion to the position of driver."

Several other important speakers followed, all more or less testifying that the problem of spreading the coal mechani-

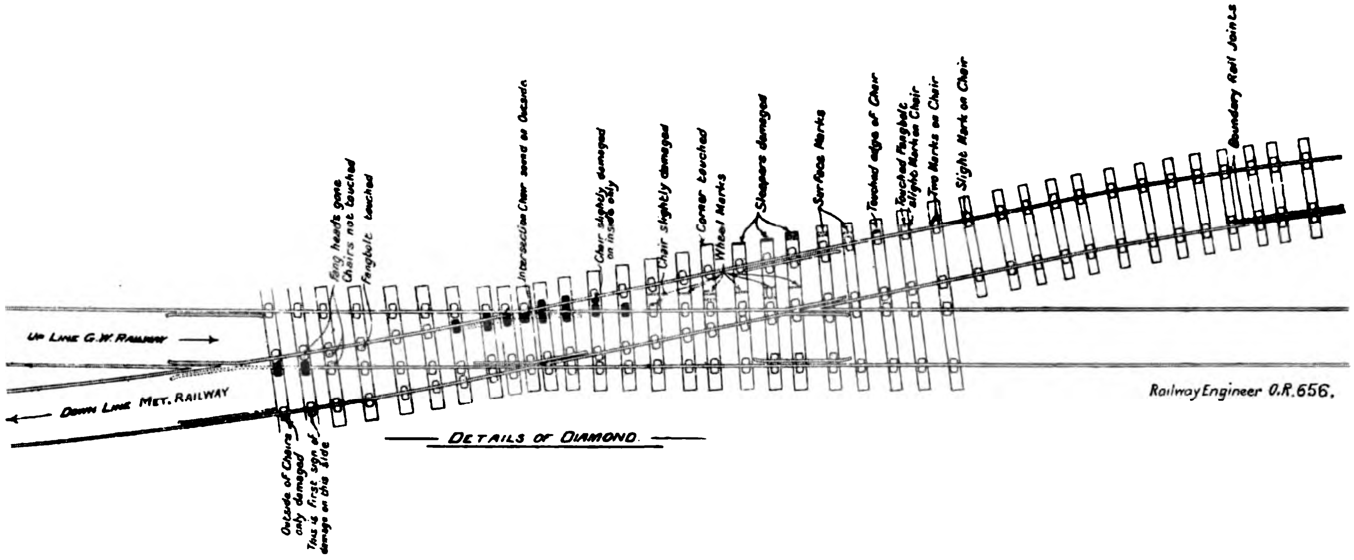
cally had been solved and that conveying it to the stoker would not be difficult to accomplish.

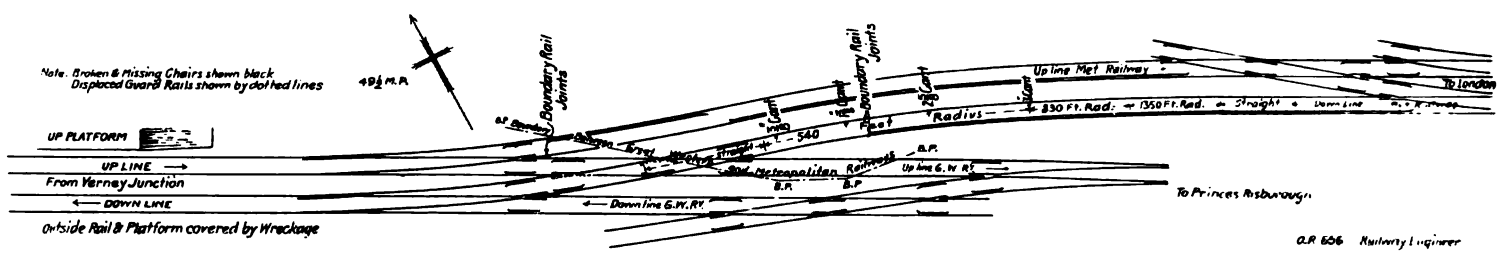
The subject was eventually referred to a standing committee to report upon.

Official Reports on Recent Accidents.

At Aylesbury Station, Met. and G.W. Joint R. *On 23rd December. Lt.-Col. H. A. Yorke, R.E., reports that:—*

The 2.45 a.m. *ex* Marylebone Great Central express passenger train (engine No. 1,040, tender and 10 vehicles) was derailed and completely wrecked. The engine, tender and three or four coaches mounted the down platform (the engine being turned over on to its right side), two coaches mounted the up platform, and the rest of the train was scattered about on the up and down lines between the platforms, for a distance of about 50 yards. The driver and fireman and a driver and a fireman travelling as passengers were killed, and four other servants were injured. There was no one else in the train.





Immediately after the derailment, the 10.20 p.m. ex Manchester Great Central passenger train came into slight collision with the wreckage, but no one was injured.

All the wheels (except engine bogie) were braked by automatic vacuum brake. The train was 482ft. 3ins. long, and, including the engine, weighed 306 tons 6 cwt.

The engine had the appearance of being a good deal knocked about, but the damage was chiefly superficial, the boiler, machinery, frame, springs and wheels being uninjured. It was lying on its right side across the down platform about 40 yards from the London end of it, with its bogie wheels overhanging the left-hand rail of the down main line. The top of it was covered with mud, and its appearance indicated that it had fallen in the first instance on to its left side, and had then rolled over on to its right side. The funnel was broken off, and the lagging round the barrel of the boiler was torn and indented. The tender was in an oblique position behind it, overhanging the rails of the loop line on the south side of the down platform, and leaning against the side of two Great Western coaches which were in turn leaning against, and supported by, some coal wagons standing on an adjacent siding. Immediately behind the tender, three or four coaches of the train were telescoped together in such a way that they appeared as one coach. Another coach was lying across the up and down lines with one end resting on the up platform, portions of two other coaches were on the up platform and the rest of the train, with the exception of the rear brake van, was broken up and scattered in all directions.

The permanent way was, considering all the circumstances, but slightly damaged. A dense fog prevailed and the fogmen were at their posts.

Aylesbury Station is the joint property of the Great Western and the Metropolitan R. Co., and the Great Central R. Co. has running powers over the lines through it. It consists of two platforms, the direction of which is approximately east and west, with up and down main lines between them. There is a loop line and also a siding on the south side of the down platform, which is in fact an island platform, and there are sidings on the north side of the up line. At the east end of the station the Metropolitan R. from Baker St. joins the Great Western R. from Princes Risborough by a double junction. The two railways are, roughly speaking, parallel to each other for about 200 yards, the Metropolitan lines being on the north side of the Great Western line, and when about 340 yards from Aylesbury Station the Metropolitan lines turn inwards and form a junction with the Great Western line by means of a reverse or S curve. The two portions of this reverse curve upon the Metropolitan line are supposed to have radii of 9 chains, but so far as the eastern portion of the curve is concerned the curvature has been slightly modified, apparently with the view of reducing the abrupt divergence from the straight and of forming some sort of transition curve. It will be seen from the plan that the curve commences with a radius of 1,350 ft., which extends for a distance of 28ft.; the radius then becomes 830 ft. for a distance of 30ft., after which it is 540ft. for a distance of

80ft. There is then a short length of 36ft. of tangent before the reverse portion of the curve begins.

The lines through the station, although the joint property of the Great Western and Metropolitan R. Co., are maintained by the former, the Great Western maintenance commencing at the spot where the check rail ends on the curve of 540ft. radius, and the administrative duties of the station are carried out under the supervision of a joint committee of the two Cos. There are two signal-boxes, viz., the East box and the Joint signal-box, the former of which is situated on the north side of the Metropolitan R., 314 yards from the centre of the station, and belongs to and is manned by the Metropolitan Co., while the latter is on the up platform about the middle of the station and is owned and manned by the joint Cos.

The only signals to which it is necessary to refer are the Metropolitan down main outer home and the down main distant signals. The former is situated 80 yards, and the latter 1,133 yards, east of the East signal-box. The speed board to which reference has already been made is placed half way between the signal-box and the down main outer home signal.

So far as the destruction of rolling stock is concerned, this is probably one of the worst cases of derailment that has occurred in the United Kingdom. Of the ten coaches forming the train, six were entirely, and one partially, demolished. The train is chiefly used for the conveyance of newspapers and parcels.

The derailment was undoubtedly due to the excessive speed of the train when passing round the curve of the junction of the Metropolitan R. with the Great Western R.

It is impossible in cases of this sort to give to the outer rail of the curve the correct superelevation. It is true that some degree of superelevation had been provided, but this consisted of nothing more than a sort of hump in the right-hand rail, which did more harm than good, as its only effect would be to cause the engine to make a nasty lurch to the inside of the curve at the moment when the centrifugal force, pressing the engine outwards, was at a maximum. The superelevation had a maximum of 3ins. at the spot where the radius of curvature changes from 830 to 540ft., and that then it rapidly decreased on the latter curve until it disappeared altogether at the place where the curve joined the tangent. It therefore follows that at the time when the lurch of the engine tended to lift the outer wheels off their rail, the rail itself was, as it were, dropping away from under those wheels. A more dangerous state of affairs could hardly be imagined. An examination of these conditions makes it apparent that the wheels of an engine could not at any time be all touching the rails at the same moment, or, if touching, could not be all carrying their proper share of the weight, and it would be better to have no superelevation at all than one that is absolutely incorrect, both theoretically and practically. The check-rail, instead of being carried right round the curve of 540ft. radius, was discontinued about 30ft. from the end of the curve; a feature which is of much importance, owing to the fact that the marks seem to indicate that it was the spot where the check-rail abruptly ends that the engine first left the rails. It is manifest that such a junction is suitable only for a very low rate of speed, and the regulations prescribed 15 miles an hour as the safe speed for it. Speed boards are erected alongside the railway at both ends of the junction to warn drivers, and a notice to the same effect is contained in the official time-books of the companies concerned.

Aylesbury Station is situated at the foot of an incline over 6 miles long, the gradient upon which is for the most part 1 in 117. It is, therefore, a place where under ordinary circumstances a high speed would be attained. The restriction of speed to 15 miles an hour was, therefore, of great importance and required to be most carefully observed. The speed limit is usually adhered to, but it was proved that on the night in question it was largely exceeded. The train register-books show that the train occupied 2½ minutes in covering the 2 m. 32 chs. between Wendover and Stoke Mandeville, and 2 minutes that, 2 m. 15 chs., between Stoke Mandeville and Aylesbury East. It is probable that the speed when the train reached the curve was not less than 60 miles an hour. No practical amount of superelevation could render it possible for a train travelling at that speed to get round such a curve as that described.

The marks on the permanent way do not afford a clear indication as to what happened, but they seem to suggest that the bogie-wheels of the engine left the rails at the end of the check-rail, where the radius of the curve is only 540ft., and took a tangential course until the inner or left-hand bogie-wheels got foul of the diamond crossing between the right-hand rails of the Great Western up and the Metropolitan down lines respectively. The guard-rail of this crossing was knocked out of place, and the bogie-wheels apparently were there diverted by the right-hand rail of the down Metropolitan line, so that the head of the engine was turned towards the down platform of Aylesbury Station, which it mounted, and upon which it and the front part of the train eventually came to rest. The smallness of the damage to the permanent way is not easy to account for.

Driver Barnshaw was fatally injured. He was a steady and reliable driver, a total abstainer, and had a good record. He entered the Co.'s service as cleaner in 1891, became a fireman in 1896, and was passed as driver in December, 1899. He had signed the usual "road paper" in October, 1901, but apparently did not on that occasion include the London section of the railway as one with which he was acquainted. However, in March, 1904, he revised his "road paper" and put his initials against the Leicester and London section to show that he knew it. It is remarkable that whereas on the up journey he had distinctly asked for a pilot-man (but subsequently refused to take one), on the down journey he only asked for an experienced fireman, which is by no means the same thing. The fireman given to him had been working between London and Manchester since 1899. Barnshaw was apparently doubtful as to his knowledge of the road between Leicester and London on both the up and down journeys, and that the anxiety he displayed at Neasden was quite as much on this account as on that of his fireman's want of experience in firing. Therefore Barnshaw himself was not justified in working, and that those responsible were not justified in allowing him to work either the up or the down train between these two places without a pilot-man, especially at night and during a thick fog, and that his mistake in failing to reduce the speed of his train before reaching the junction at Aylesbury Station was probably due to his lack of familiarity with this section of the railway, and, either altogether forgot the existence of the curve and speed restriction at the junction, or, owing to the thick fog, failed to locate himself correctly. All the signals were "off" for the train at Aylesbury, as well as at Wendover and Stoke Mandeville, so that although the fog-men were out, no detonators were on the rails. The speed board is much too near the danger spot to be of any practical use.

The most obvious lesson to be derived from this disaster is that a junction with such curves as described should not be allowed to exist on a main line over which high speed trains are constantly run. So long as the line was used only by Metropolitan trains, all of which stop at Aylesbury, the objections to the lay out of the junction were not serious, but the junction is eminently unsuitable for the fast trains of the G.C.R. It is therefore very desirable that the Met. and the G.W.R. Co. should agree to form an entirely new junction between their respective systems. The check rail should be carried round the curve until it joins the wing rail of the V crossing between the left hand rail of the Met. down line and the left hand rail of the G.W. up line. The superelevation should also, if possible, be improved, or, preferably abolished altogether. In its present condition it is too great at its maximum point for a speed of 15 miles an hour, and far too little for a speed of 50 or 60 miles an hour.

The speed board should be moved further out, or else some other means of warning a driver to reduce his speed should be adopted.

Upon French railways a special signal (*signal de ralentissement*) is used for the purpose of warning drivers when they have to slacken speed. In England no such signal has been adopted, but the distant signal could be utilised by keeping it permanently at danger, so that it would act as a constant reminder to drivers that speed is to be reduced.

Another matter of considerable importance is the necessity for some more stringent supervision on the G.C.R. over the signing of the "road papers" by the drivers. The present method seems to be highly unsatisfactory, as a driver is allowed to sign a "road paper" on his own responsibility without any adequate steps being taken to ascertain whether he is acquainted with the road or not, nor are the papers counter-signed by any responsible officer of the Co. Drivers should only be permitted to sign these "road papers" in the presence of a responsible officer, and after being examined by the latter as to their knowledge of the road and regulations, and the officer should date and countersign the paper and add any remarks which occur to him. The same procedure should also be invariably adopted when any revision of these papers is made.

The collision of the up train with the wreckage was unavoidable. The driver of the up train had already reduced his speed on approaching Aylesbury in compliance with the regulation, and the signalman, fogman and driver all acted with commendable promptitude.

*

At Huddersfield, L. & Y. and L. & N.W. Joint Station. *On 21st April. Lt.-Col. E. Druitt, R.E., reports that:—*

The L. and Y. 2.20 p.m. train (radial 4-coupled tank engine and 7 vehicles) from Mirfield was run into by a L. and N.W. engine and 3 vehicles.

Two passengers were killed and 9 injured, and 4 servants were also injured.

The L. and Y. train was fitted with the automatic vacuum brake operating on 36 out of its 44 wheels.

The L. and N.W. engine, 6-coupled bogie, with tender, was running tender first. It weighed about 90 tons. It was pulling two corridor thirds and a van.

The first three coaches of the L. and Y. train were telescoped and the second one completely broken up.

At a distance of 100 yards east of the station is No. 2 signal-box, which controls all the movements of trains approaching from the eastward, the bridge of up directing signals to the platform roads being 112 yards east, and the up home signals 204 yards east of the signal-box.

The L. and N.W. engine, No. 610 (driver Haigh), arrived at Huddersfield No 2 signal-box about 1.50 p.m., in order to get on to the turntable to turn, the turntable at Hillhouse depôt, a mile or so away, being too small. But the turntable road was blocked by three empty coaches, and as the sidings were all full, driver Haigh, under instructions from signalman Payne and shunter Alford, drew the empty coaches out with his engine on to the down main line, and then backed them through the cross-over road on to the up main line inside the station. As soon as his engine was uncoupled, Haigh took it back through the cross-over road to the down main line, and then backed on to the turntable, where the engine was turned with the assistance of shunter Alford.

Haigh then took his engine out on to the down main line again and backed it through the cross-over road on to the empty coaches he had left standing on the up main line, which had to be replaced in the turntable road. The engine was coupled on to the empty coaches by shunter Alford. All the movements of the points for these operations were carried out by signalman Payne in response to the information shouted to him by Alford; and the disc signals for backing through the cross-over road from the up to the down main line, and for coming out of the turntable road on to the down main line were lowered to safety for the movements they covered.

Just as signalman Payne had lowered the disc signal for the engine to come out on to the down main line after it had turned, he states he was offered the L. and Y. passenger train, from Hillhouse No. 1 signal-box, on the up south line, and he accepted it at once, the time being 2.33 p.m., and as soon as the L. and N.W. engine had gone through the cross-over road on to the up main line Payne offered the L. and Y. train to the No. 1 box at the other end of the station, on the up and down platform No. 2 road, and it was accepted at once, so Payne restored the points of the cross-over road to the normal position, and set the road to lead from the up south line to No. 2 platform road, and lowered all the signals for the L. and Y. train at 2.34 p.m.

Before these signals could be lowered it was necessary, owing to the interlocking of the levers, to place the cross-over points and the disc signals relating to those points in their normal position.

As soon as the L. and N.W. engine had backed on to the empty coaches at 2.34 p.m., shunter Alford coupled it on again, and went back to the van to take off the hand brake which he had appled when the coaches were placed on the up main line, and driver Haigh started almost at once without looking at the disc signal alongside his engine, thinking he was going back through the cross-over road on to the down main line and thence to the turntable road. He did not notice that he did not go through the cross-over road as he was expecting to do, and the result was he ran past the cross-over road on the up main line in the facing direction, and after going another 45 yards he ran into the L. and Y. incoming train just after the latter had taken the points of the crossing to the up and down platform No. 2 road, the two engines meeting almost buffer to buffer.

There are some discrepancies in the evidence of driver Haigh and that of shunter Alford and signalman Payne, but assuming Haigh to be correct he is solely to blame for not looking at the disc signal at which he was standing before moving his engine; he had only to look over the side of the footplate to see it.

He should also have noticed that his engine did not go through the cross-over road but continued running in the facing direction on the up main line, an absolutely unauthorised movement; and if he had been looking out he should have seen the L. and Y. train approaching, whereas he did not see it until he heard the whistle of the other engine, when it was too late to stop.

He is an experienced man with a good record, having been a fireman for 9 years and an engine driver for 16 years. He had been on duty 10 hours.

*

Near Stratford Market Station, G.E.R. *On 5th April. Lt.-Col. P. G. von Donop, R.E., reports that:—*

The 2.31 p.m. goods train, London Docks to Victoria Docks, consisting of an engine, 14 wagons and a van, was run into by the 2.48 p.m. up train, Stratford Market to Stratford Fork carriage sidings (engine and 12 empty carriages).

The engine of the goods train was overturned and the fireman was found underneath it, having been killed instantaneously. The drivers of both engines were seriously injured; the fireman of the empty carriage train and both guards were slightly injured.

The engine of the 2.31 p.m. train was fitted (all wheels) with the Westinghouse automatic brake.

The collision was entirely due to driver Webster (up train) having allowed his train to start from Stratford Market Station while the up starting signal was at danger. He had been on duty close on 10 hours.

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Contents for October.

Mr. J. C. Inglis, general manager of the Great Western R., has been appointed to represent the Government on the Arbitration Board which is to fix the price to be paid by the Government for the Singapore Docks. Mr. Inglis has left for Singapore, and will, it is expected, be away from Paddington about twelve weeks. The vendors, the Tanjong Pagar Docks Co., Ltd., will be represented by Sir Ed. Boyle, K.C., and the two arbitrators have selected Sir Michael Hicks-Beach to be umpire.

Mr. R. Y. Vickers, assistant traffic manager, Hull, Barnsley and W. R. T. R., has now been appointed superintendent of the line, and **Mr. John Shaw,** the assistant goods manager, has been appointed goods manager.

Mr. T. H. Roberts, superintendent of the Reading division (now absorbed in the London division) of the Great Western R., has been appointed superintendent of the newly created Gloucester division.

IT is announced that **Mr. W. H. Adams** and **Mr. C. H. Jones,** superintendents of the running departments of the northern and southern divisions respectively of the Midland R., will shortly retire under the age limit rule, and that in consequence **Mr. Cecil W. Paget,** manager of the locomotive works, Derby, has been appointed chief assistant to the locomotive superintendent (in addition to his present office) as from the 1st November next.

Mr. W. Panter, carriage and wagon superintendent L. and South Western R., will soon reach the age limit, and though offered the option of remaining, has decided to retire at the end of the year.

Mr. Kenneth R. N. Speir, of the locomotive department, Midland R., Derby, has been appointed secretary to the President of the Egyptian State Railways.

Mr. W. G. Hornett, of the locomotive and wagon department, Great North of Scotland R., Inverurie, and previously on the Great Eastern R. at Stratford, has been appointed assistant carriage and wagon superintendent of the Bengal Nagpur R.

WE regret to record that **Mr. John Stoddart,** goods and mineral plant superintendent, Caledonian R., died, after a lingering illness, at his residence on the 8th ultimo.

Sierra Leone Railway.

THE last section of this railway, Bo to Baiima (84 miles), including the bridge 633ft. long over the Moa River, was opened on the 23rd August. The total length of the line (now open throughout) is 220 miles.

*

Victoria Falls Bridge.

THE great bridge over the Zambesi River, just below the Victoria Falls, was formally opened by Professor Darwin on the 12th ultimo. The Falls are 1,631 miles by rail from Cape Town, and can be reached in 21 days from London.

*

Charges for Royal Specials in Germany.

WHEN the German Emperor (or the Empress separately) travel by special train every journey is paid for by the Kaiser to the Administration of the Prussian State Railways, to which the Royal trains belong. Thus the Kaiser's recent journey from Berlin to Elbing, a distance of about 315 miles, cost £340, or just over £1 a mile. The rates paid by the Court train are reckoned on the same scale as the charges for any other special train, that is, 14*d.* for every kilomètre (0·621 mile) run by the locomotive, 5*d.* for every axle-kilomètre for the carriages, and 2½*d.* for every axle-kilomètre for the luggage or police cars. The return journey costs the same, as the reduction on a return ticket does not apply to an Imperial train. Every Court train carries an official, who is responsible for the train and its safe running; every car is under the special supervision of an engineer, and every provision is made for repairing without loss of time any accident to the train while on a journey across the open country. In fact the arrangements are similar to those in vogue in this country for Royal trains.

*

Passengers' Complaint Books.

AT the stations of the Bavarian State Railways the traveller with a grievance, and when was there not such a traveller to be met with always and everywhere, has been able to make his complaint in writing in an official book kept for the purpose. But these books have become a great nuisance to the railway authorities, who are discussing the question of abolishing them, because in their own words, "of late years the number of complaints has increased considerably." To the outsider such a result would seem to imply that the books were needed in the interests of the travelling public. The authorities, however, say that very many complaints proved to be unfounded, that much time was taken up in investigating them and in answering the complainers, and that as the greater part of the complaints are written under the

stress of more or less excitement the element of truthfulness in them suffers in consequence. Such books on our home railways would furnish some delightful reading for leisure hours.

*

Raising Trees for Sleepers.

THE Cape Government, Railway Department, have four nurseries in which are raised trees destined to supply sleepers in the future.

At the nurseries at Elgin and Knol Vley 918,756 have been raised at an average cost per 100 of 12·26*d*. and 11·54*d*. respectively. These figures refer to young Eucalypts rooted in tins.

The areas of the plantations are 405 acres at Elgin, 570 acres at Epping, 296½ acres at Helderberg, and 522 acres at Knol Vley, Including clearing, ploughing, planting, &c, the total expenditure at these four plantations during the six months ended 30th June. 1904 was £2,528. At Knol Vley alone there are about a million established plants. The value of these plantations will be appreciated when it is remembered that in 1903 the Cape Railway Department imported timber to the value of £303,137, and the other government departments to the value of £727,501.

*

Passenger's Eye Injured by a Spark.

AN interesting case of importance to railway companies, viz., Atherton v. the L. and North-Western R. Co., was before the Court of Appeal shortly before the vacation.

At Huyton station one of the exits for passengers is by a pathway belonging to the railway company close to, but separated from, the railway by a post and rail fence. There is also another but more circuitous exit from the platform. The plaintiff on alighting from the train from Liverpool proceeded by the pathway, and as the train passed him a spark from the locomotive entered one of his eyes and injured it. No complaint was made as to the construction of the engine, but negligence alleged was that the pathway had not been so screened as to protect passengers using it from sparks which all engines were liable to emit when starting. It appeared that at the beginning of last year the ratepayers at Huyton had petitioned the L. and North-Western R. Co. to screen the pathway, but the company declined to incur the expense. The plaintiff had signed this petition and was therefore aware of the danger of using this exit. Mr. Justice Walton, who tried the case at Liverpool, decided that there was evidence of negligence, and a special jury awarded the plaintiff £25 damages. The L. and North-Western R. Co. appealed for a new trial on the ground of mis-direction of the jury as to whether there was evidence of negligence.

The Master of the Rolls concluded a lengthy and considered judgment by saying the verdict of the jury ought not to be disturbed. Mr. Justice Romer also delivered a written judgment to the same effect, and Mr. Justice Mathew concurred. The appeal was therefore dismissed.

*

Milling Testing Plant and Hardening Cutters.

MR. G. M. BASFORD, editor of the *American Engineer*, writes to his journal that at Borsig's locomotive works a milling testing machine has been laid down and has proved to be very profitable:—

"A special motor drives a large new milling machine, and a good man is constantly employed in making tests of cutters of various kinds upon broad surfaces of cast iron and steel. By weighing the work and reading the ammeter the power required per unit weight of metal removed is studied, and this experimental work had greatly increased the rate of cutting and reduced the cost of milling. This, by the way, is an admirable demonstration of the convenience of electrical measurements in introducing improved methods in the shops.

"The tempering of milling cutters was watched with interest. Gas furnaces are used, and the cutters are heated very slowly. Until red hot they are not put into the furnace at all, but are heated by radiant heat by being placed on a plate under the furnace, the gas burner of which heats cutters to a high temperature in the furnace while it heats to a red temperature those which are to go into the furnace. This is said to be the secret of hardening good cutters.

"Small pieces of high-speed steel were in some mysterious way stuck on the ends of large lathe and planer tools. The joints were fused and resembled brazing, but they hold heavy cuts. I did not succeed in impressing the works manager with the desirability of telling me how it was done or letting me see the process."

*

Scottish Railways.

THE construction of the extension of the North British R. at Falkirk is progressing rapidly. The object of the line is to give through communication from the West and North to Grangemouth. The extension leaves the main line at Sunnyside, and passes through Bainsford to Orchardhall, where it joins the Caledonian R. Co.'s new line at Fouldubs. The length of the new railway will be 2¾ miles, and it will be used principally for mineral traffic.

In the latest returns of the Board of Trade the Scottish railway companies have a good record so far as the working of long hours by their servants is concerned. The North British R. figures twice, the Great North of Scotland R. once, and all the others not at all.

As some doubt has been entertained by the officials of the North British R. as to whether the tunnels on their system were wide enough for the East Coast Companies' latest type of coach to properly pass through, a train of empty coaches has recently been employed to test the clearances of the tunnels and curves.

*

Morse Chain.

THE Westinghouse Brake Co., Ltd., have completed new works at York Road, King's Cross, London, equipped with the most modern tools for making and testing the Morse Rocker Joint High Speed Chains, which, with the double pintle designed to eliminate all sliding friction, have met with great success since their introduction in America. The company have secured the exclusive right to manufacture and sell these chains in this country and on the Continent.

*

A Very Fast Run.

WHEN the distance from Chicago to Buffalo, over the Lake Shore and Michigan Southern Railway, was covered at an average speed of 65·07 m.p.h. on Thursday, October 24, 1895, a world's record was made for this distance. On June 12 and 13, 1905, a train of three private cars was run over the same road, a distance of 525 miles, at an average speed of 69·53 m.p.h. including stops, and an average speed of 70·94 m p h. excluding stops. This was a special train composed of three officers' cars weighing 175 tons back of the tender. The accompanying table contains the official record of the speeds over each division, the figures having been taken from the train dispatchers' records. Locomotive No. 3707 is of the new class K, 2—6—2 type, and is the heaviest passenger locomotive in the world at the present time. That this very heavy locomotive made such speed is worthy of special record. The figures presented include the length of each division, the time of departure and arrival, the time over each division, the

distance and speed in miles per hour. All of the locomotives concerned in this remarkable run were built at the Brooks works of the American Locomotive Company.

That the record made last June did not involve any special preparation, whereas that of October 24, 1895, required extraordinary preparation, is a fact worthy of note. The record given in the *American Engineer* is as follows:—

LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY.

Westbound, June 12th, 1905.		Private cars 201, 203, coach 340.		
		Time.	Distance.	Per hour.
Engine 4,692 (2-6-2).				
Lv. Buffalo ...	5.15 a.m.			
Av. Cleveland ...	7.50 a.m.	*2 hr. 35 min.	183 miles.¹	*70·8 miles.
Engine 4,665 (2-6-2).				
Lv. Cleveland ...	8.00 a.m.			
Av. Toledo ...	9.33 a.m.	1 hr. 33 min.	108 miles.	69·66 miles.
Engine 5,003 (4-6-0).				
Lv. Toledo ...	9.36 a.m.			
Av. Elkhart ...	11.30 a.m.	1 hr. 54 min.	133 miles.	70·00 miles.
Engine 695.				
Lv. Elkhart ...	11 33 a.m.			
Av. Chicago ...	1.05 a.m.	1 hr. 32 min.	101 miles.	65·86 miles.

*Including a 2-minute stop at Erie.
Average speed 525 miles, including stops, 67 02 m.p.h.
Average speed 525 miles, excluding stops, 69·69 m.p.h.

Eastbound, June 13th, 1905.		Private cars 201, 203, coach 340.		
Engine 695.				
Lv. Chicago ...	6.30 a.m.			
Av. Elkhart ...	8.22 a.m.	1 hr. 32 min.	101 miles.	65·86 miles.
Engine 4,661 (2-6-2).				
Lv. Elkhart ...	8.24 a.m.			
Av. Toledo ...	10.18 a.m.	1 hr. 54 min.	133 miles.	70·00 miles.
Engine 4,665 (2-6-2).				
Lv. Toledo ...	10.20 a.m.			
Av. Cleveland ...	11.51 a.m.	1 hr. 31 min.	108 miles.	71·20 miles.
Engine 3,707—685.				
Lv. Cleveland ...	11.55 a.m.			
Av. Buffalo ...	2.25 p.m.	*2 hr. 30 min.	183 miles.	*73·20 miles.

*Including a 3-minute stop one mile east of Dunkirk.
Average speed 525 miles, including stops, 69·53 m.p.h,
Average speed 525 miles, excluding stops, 70·94 m.p.h.

Books, Papers and Pamphlets.

The World's Locomotives. By CHAS. S. LAKE. London: Percival Marshall and Co., 26-29, Poppin's Court, Fleet Street, E.C.

This book is not, and does not pretend to be, a text book of the design and construction of locomotives; it deals entirely with the completed machine in all its varieties and sizes.

It sets out clearly and concisely the principal particulars of contemporary locomotives constructed during the last few years, and thereby brings into comparison the efforts made in the different countries of the world by locomotive engineers to meet the ever-increasing demands of the traffic departments. The two opening chapters are very interesting. They refer to individual examples of modern locomotives, particularly those which are furnished with some notable appliance, or fitting such as serve tubes, special blast pipes or spark arresters, cross water tubes, "coned" boilers, corrugated fire-boxes, liquid fuel, superheaters, &c. In Chapter II. the American classification by the arrangement of the wheel base is explained with diagrams and a table of the corresponding American names.

The next seven chapters deal with British locomotives, separate chapters being devoted to the 4-4-0 type; the 4-4-2 type; other types of express engines; tank engines; shunting, light and crane locomotives; goods locomotives and compound locomotives. A fairly long chapter given to Colonial and Indian locomotives is followed by four chapters devoted to foreign and Continental locomotives, and by two on American passenger and goods engines respectively. In an appendix particulars are given of Mr. Whale's "Experiment" class and of Mr. Churchward's latest tank engines. Such references show that the book is quite "up to date."

The author may be congratulated on having written a very useful work, as it collects into a convenient form for reference the leading particulars of all the principal types of modern locomotives. This could not have been a very easy matter, but the author having been trained as a locomotive engineer, and having subsequently been accorded most exceptional facilities for studying the operation of locomotives, has been able to accomplish his task without unduly increasing the size of the volume or without neglecting any important type of engine.

The book is profusely and well illustrated with views of the engines. In addition eight large sectional drawings are given, besides smaller ones of special parts and details. It is beautifully printed, and its "get up" generally is excellent. It is published at a very low price, and is, we think, certain to command success, as it is undoubtedly the best work of its kind.

*

Railways and their Rates. By EDWIN A. PRATT. London: John Murray. 1905.

This book treats the subject Railway Rates from the railway companies' point of view, and it is to be hoped that it will be widely read by traders and the general public, particularly the former.

The causes which have made the capital cost of railways in this country great in comparison with those of other countries are examined and reviewed, and the conclusion is drawn that our railway rates might reasonably be expected to be heavier than they are abroad. Stress is laid upon the expensive system of small consignments in vogue in this country, coupled with the short haul which is inevitable in a small island. It is also pointed out that British traders will not combine to send large consignments, but insist upon their individual small lots being delivered with the utmost speed.

In comparing British and Continental rates Mr. Pratt is most interesting, and demonstrates that the unfavourable comparisons about which we hear so much are almost invariably obtained by comparing domestic with export rates or by comparing the rates for unlike services rendered. Another excellent and very important chapter is that on the Taxation of Railways, in which it is shown that local improvements are being largely carried out at the expense of railway shareholders and traders and passengers who use railways.

Chapter X.—on Sundry Services—explains the free warehousing system which competition has forced upon railway companies. One has only to reflect upon the value of land in the heart of large towns and cities and upon the cost of the vast fireproof warehouses to appreciate the capital outlay railway companies have incurred to secure traffic for their lines. And when it is remembered that goods of all description are warehoused free for, in some cases, 14 days both before and after carriage, some idea of the services rendered to traders and manufacturers will be obtained. Notwithstanding the innumerable tirades that have been penned on the iniquities of railway companies in general and the enormities of their rates in particular, we do not remember ever to have seen the warehousing facilities mentioned before.

Mr. Pratt remarks: "Newspaper managers find the arrangement especially convenient and economical in regard to the storage of the paper they use, though newspaper editors are none the less ready to encourage and to support complaints as to the 'extortionate' character of railway charges in general."

Several striking examples are given, *e.g.*, "A consignment of

"85 bales, warehoused and redistributed by the railway company "in twelve separate deliveries. Warehouse rent, 2s." In this instance there would have been no charge had not the "free" period of time been exceeded. Such examples may cause one to wonder whether this warehousing system is "good business," but it should be remembered that such services as that above mentioned often secure large traffic accounts miles away.

The chapters dealing with the Carriage of Dead Meat, Fish, and Fruit and Vegetables are crowded with information of particular interest to all consumers who have been taught to believe that the price of food depends upon railway rates. This is, of course, an absurd fallacy, and Mr. Pratt tells how the railway company (now the Great Central) created Grimsby and made it the greatest fish mart in the world, and now carries its catches to London for one-sixth of a penny per pound. Also that the railways receive just over 0.62*d.* per pound for carrying soles (and other fine fish) from Wick to London (749 miles) in 1 cwt. lots; this example is interesting because the retail price of soles in London is generally about 24*d.* per lb.

Then about the rates on fruit and vegetables, both British and Continental, Mr. Pratt tells us a great deal. It appears that for bringing fruit from Maidstone and delivering at Covent Garden the railway company receives about one-tenth of a penny per pound; green peas from Braintree 3¾*d.* per bag, whilst the salesman charges a commission of 6*d.* per bag for selling them. Mr. Pratt devotes some pages to the examination of market salesmen's commissions. He shows them to be generally about equal to the railway rates, and comments upon the difference between the services rendered to the grower for similar payments. Many other examples will be found in the book, as well as a full discussion of the Continental rates and regulations for fruit and vegetables.

The chapter on General Continental Considerations is followed by five others, dealing respectively with the railways of France, Germany, Holland, Belgium and Denmark, all of which are most interesting, and contain much useful information.

The book concludes with a brief review of the British Canal Problem and its connection with railways.

Mr. Pratt has not only written a most instructive book, but he has also thereby rendered the railway interests of the country a signal service.

*

Books Received.

Machine-Shop Tools and Methods. By W. S. Leonard. With nearly 700 illustrations. New York: John Wiley & Sons; London: Chapman & Hall, Ltd. 1905. [561 pp. 9ins. x 5¾ins.; price 17*s. net.*]

The Merchantable Timbers of Queensland. With special reference to their uses for railway sleepers, railway carriage and wagon building, and engineering works. A Report by Philip MacMahon, Director Government Botanic Gardens, Brisbane. Issued by authority of Hon. Digby F. Denham, M.L.A., Secretary for Agriculture. Brisbane: George A. Vaughan, Government Printer, William Street. 1905. [68 pp. 14 ins. x 11¼ins. and 60 plates.]

Permanent Way for Tramways and Street Railways. By Thos. Arnall Assoc. M. Inst., C.E. London: The Publishers of *The Railway Engineer*, 3, Ludgate Circus Buildings, E.C. [246 pp.; 9¾ins. x 7¼ins.; illustrated; price 12*s.* 6*d. net.*]

Records of Recent Construction by the Balwin Locomotive Works, Philadelphia, U.S.A.:—

No. 51. *Recent Locomotives.*

No. 52. *Forged and Rolled Steel Wheels, manufactured by the Standard Steel Works.*

No. 53. *Notes on the Principles and Performances of the Balanced Compound Locomotive.*

British Standard Specifications for:—

No. 16. *Telegraph Material.*

No. 23. *Trolley and Groove Wire.*

Reports issued by the Engineering Standards Committee, Leslie S. Robertson, M. Inst. C.E., secretary. London: Crosby, Lockwood and Son, 7, Stationers' Hall Court, E.C. December, 1904. [Price of No. 16 10*s.* 6*d.*, and of No. 23 1*s.*, both *net.*]

"*Red Books*" *of the British Fire Prevention Committee.* Edited by the Executive. London: Published at the Offices of the Committee, 1, Waterloo Place, Pall Mall. [Price 2*s.* 6*d.* each.]

The Committee Reports on Fire Tests:—

No. 95. *Three Vertical Openings filled with wired Glass* by Messrs. Pilkington Bros., Ltd.

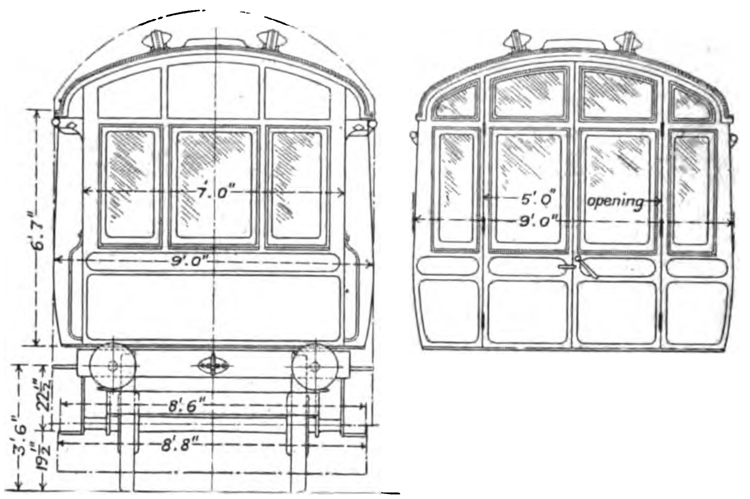
No. 96. *Four Horizontal Openings filled with Wired Glass* by Messrs. Pilkington, Ltd.

Rail-Motor Carriages; London and North-Western Railway.

A frequent rail-motor service has quite recently been established on the L. and North-Western R. between Prestatyn and Dyserth in connection with the trains from and to Chester and Rhyl. We illustrate here with the vehicles used, and it will be noticed that they have several novel features.

The car body entirely encloses the boiler, and is provided with double doors 5ft. wide at one end. The engine bogie is self-contained with its engine, boiler and tank; it supports one end of the body and is attached to it by the centre (as explained below), so that when this end of the body is lifted clear of the centre the engine bogie may be drawn away (the boiler passing out through the end doors of the body) and replaced by another. By this arrangement the carriage is not laid up when the engine or boiler require repairing.

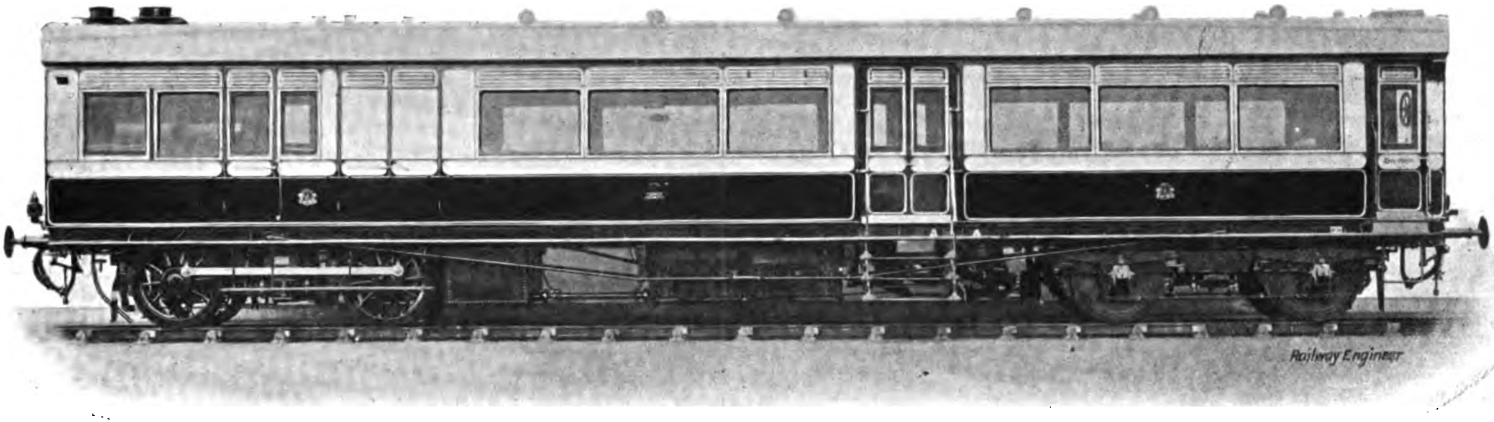
The cylinders are inside the frames, and the engines have been very carefully balanced, with the result that the vehicles run very smoothly and without vibration.

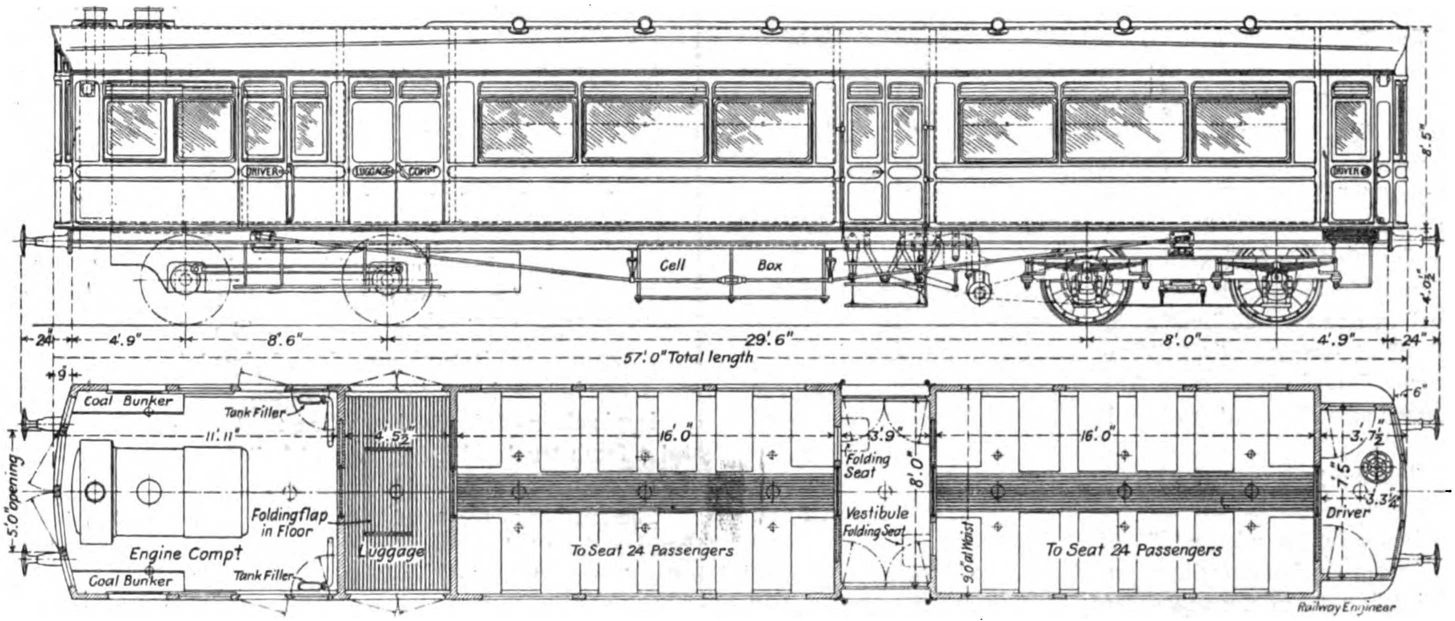


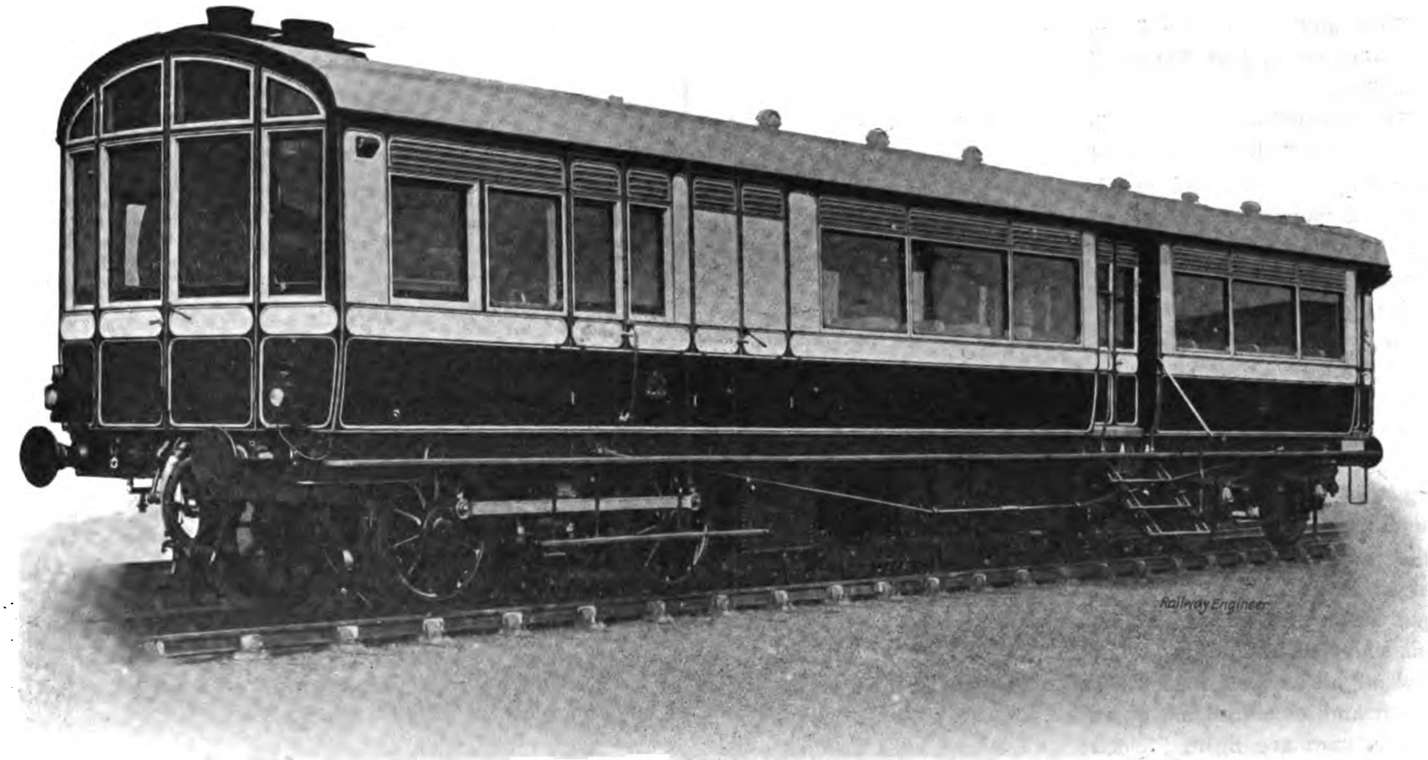
The underframes and bodies were constructed at Wolverton to the designs of Mr. C. A. Park, carriage superintendent, and the engines at Crewe to the designs of Mr. G. Whale, chief mechanical engineer, and to these gentlemen we are indebted for the drawings, photographs and particulars given below.

The carriage seats 48 passengers; its general arrangement is shown by the plan. The body is 57ft. long on the centre line and 55ft. 6in. at the sides, 9ft. wide at the waist and 8ft. 5in. high in the middle, and 6ft. 7in. at the side cornices, all outside. The roof is eliptical in section throughout.

The two passenger compartments are each 16ft. long by 8ft. 5in. wide inside. The passengers' entrance vestibule is between them and is 3ft. 9in. long by 7ft. 6in. wide; the luggage compartment is 4ft. 8½in. long; the engine room 11ft. 7in. long, and at the other end of the car is the driver's vestibule, 3ft. 3in. long by 6ft. 11in. wide.







Rail-Motor Carriage; London and North-Western Railway.

In the two large compartments the seats are arranged transversely on each side, with gangways down the middle; each seat is double and reversible, so that passengers can face the way the car is travelling; the end seats are fixed. The seats and backs are supported in iron frames. They are covered with closely woven Rattan, and are very comfortable and roomy. Each compartment seats 24 passengers. The ends are provided with brass parcel racks. One compartment is for smokers.

The interior (except the luggage compartment and engine room) is finished in framed teak with wainscoat oak panels, secured with bilection mouldings all polished. Over each of the large glass lights are arranged two folding push-and-pull ventilators, which admit, from under outside bonnets, fresh air. Torpedo air extractors are fixed on the roof.

In all the partitions of the car sliding doors are provided, those at either end of the entrance vestibule having glass centre panels. There are on each side of these doors fixed glazed lights, which give the appearance of one long compartment. Over the tops of doors and side windows is run a moulded cornice in charrier wood design all round each compartment 6ft. 4½in. above the floor level. Above this cornice the eliptical roof springs. The side coves form a frieze which is carried under the roof at the ends, thus forming one large centre panel made with margin in charrier moulding, mitred at corners and filled in with alternate plain and reeded narrow Kauri pine slats. The whole roof inside is painted enamelled white, which gives it a very light and airy appearance.

The luggage compartment has double folding doors on each side of car for passengers' luggage, and is painted and grained on sides with roof white.

In the engine compartment the walls and roof are cased with thin steel plates and painted black below side lights and buff above window sills.

Each end of the car is well provided with glass lights (the side ones to drop for ventilation), giving a good look-out for driver.

The underframe upon which the car body is mounted is made of steel channels and plating throughout. It is well trussed to carry the weight of accumulators, dynamo, water tank and vacuum cylinders at the centre. The wheel base and dimensions of the mounted body are:—Engine wheel centres, 8ft. 6in.; carriage wheel centres, 8ft.; centres of bogies, 37ft. 9ins.; centres of extreme wheels, 46ft.; length of car, 57ft.; length over buffers, 61ft.; height from rail at centre, 12ft. 5½in.; height from rail at side cornice, 10ft. 7½in.

The entrance vestibule is in charge of the conductor. Its entrance doors on each side of car door are provided with steps and hand rails to enable passengers to enter and leave the car at the intermediate stations where the platforms are built at rail level. These steps are swung to the side of the car when travelling, and are so arranged that while they are open a valve in the main vacuum brake pipe is held open. This valve cannot be shut, and the driver therefore cannot blow off his brakes until the steps are folded to the side of the car and locked in that position.

The cars are lighted electrically throughout on Stone's system. In the passenger compartments, three 2-light polished brass pendants are provided. The deck lights, tail lights, and head lights are also lighted electrically, with provision for petroleum lighting if required. The main switchboard is fixed in the engine compartment.

Electric bells are provided, and also speaking tubes, so that the driver, fireman, and conductor are all in communication with one another. The conductor is in communication with the driver and fireman with an electric bell code, and the driver and fireman can communicate with each other either by means of an electric bell or with the speaking tube.

The Consolidated system of heating is provided in the passenger compartments, the long heaters being run, under grids, along each side on the floor which is covered with "Kork" linoleum, protected by narrow oak slats, screwed on, in gangways between chairs.

The cars are equipped with the automatic vacuum and hand brakes, which can be operated from either end of the vehicle.

In designing the engine truck one of the objects which Mr. Whale had in view was, not merely to make it a carrier for one end of the carriage, but to construct it to carry the engine, boiler valve gear, water tanks, and all the engine mechanism entirely independent of the carriage, and at the same time connect it to the latter in such a way that it could be readily removed and replaced by a similar truck. This idea has been carried out, and if at any time the engine or boiler require such extensive repairs as would under ordinary circumstances necessitate the carriage being laid up, all that is necessary is to raise one end of the carriage until the bolster casting is clear of the engine, when the latter can be removed and a fresh truck with engine and boiler complete put in its place.

The frames of the truck are ⅞in. steel plates, the distance between them being 3ft. 1in., and to these frames is attached a floating steel casting carried on spiral springs connected to the truck frame. Immediately above this casting and resting on it is a steel bolster firmly secured to the carriage frames, and which has a projection in the form of a centre pin 8¾in. diam., which engages freely in a hole in the centre of the floating casting, and thereby attaches the carriage to the engine truck. This arrangement permits of sufficient side play to allow the coach to pass with ease round curves 2½ chains radius.

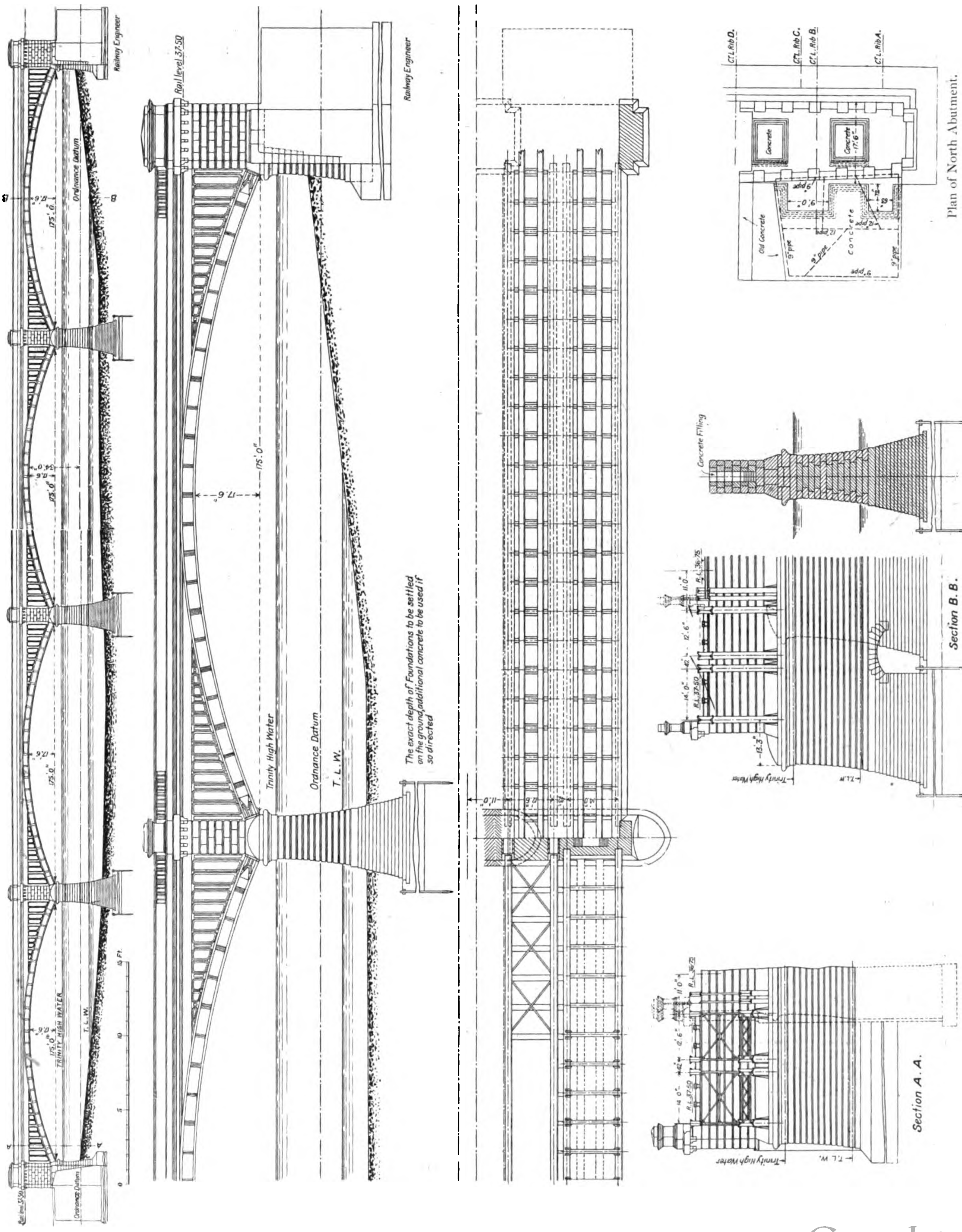
The engine cylinders are 9½in. diam. by 15in. stroke; the valve gear is of the ordinary straight link type. The wheels are 3ft. 9in. diam. with 3in. tyres. The big-end journal is 6in. diam.; the main bearings 6½in. diam. by 10in. long, and the wheel seats 7½in. diam. by 8½in. long.

The boiler is of the ordinary locomotive type. The working pressure 175 lbs. per sq. in. The barrel is 3ft. 9in. diam., and contains 216 tubes, 1½in. outs. diam. by 3ft. 3in. long between the tube plates. The fire-box is 2ft. 9in. long by 3ft. 9in. wide. Total heating surface is 317·27 sq. ft., and the grate area 6·38 sq. ft. The height of the centre line of the boiler above the rails is 7ft. 11in.

Three tanks for carrying water are attached to the engine truck and one to the carriage underframe, the total capacity being 455 galls. The coal capacity of the bunkers is 16 cwts.

The engine can be driven and the car entirely controlled from either end, so that the driver always travels in front.

The weight of the vehicle with the tanks and boilers full is 43 tons 8 cwts., of which 27 tons 8 cwts. are carried by the engine truck and 16 tons on the carriage truck.



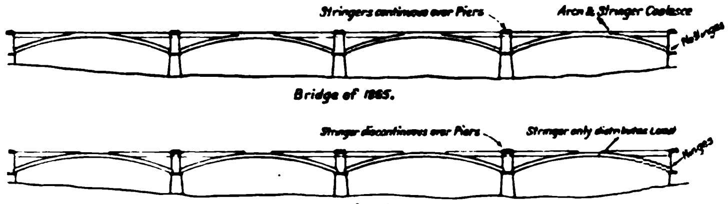
Widening of Grosvenor Bridge; London, Brighton and South Coast Railway.

Widening of Grosvenor Bridge; L., Brighton and South Coast Railway.

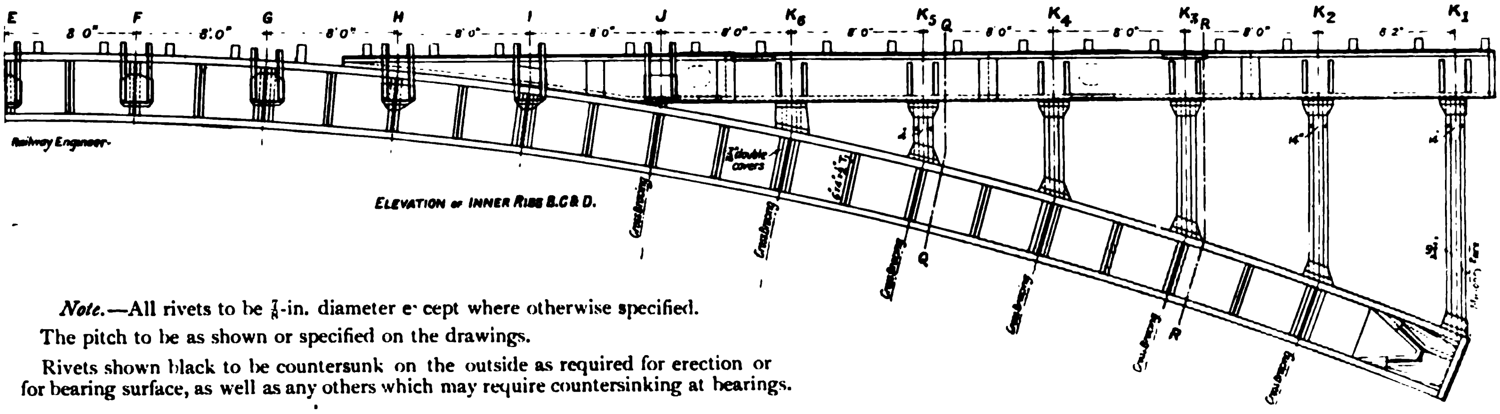
In the article in the last issue of *The Railway Engineer* on the widening of Grosvenor Bridge it was stated that while the main dimensions were necessarily the same the designs of the two previous bridges were essentially different in principle.

The reasons for this statement were not, perhaps, very apparent, but the following explanatory remarks, together with the annexed diagram, will make the matter quite clear.

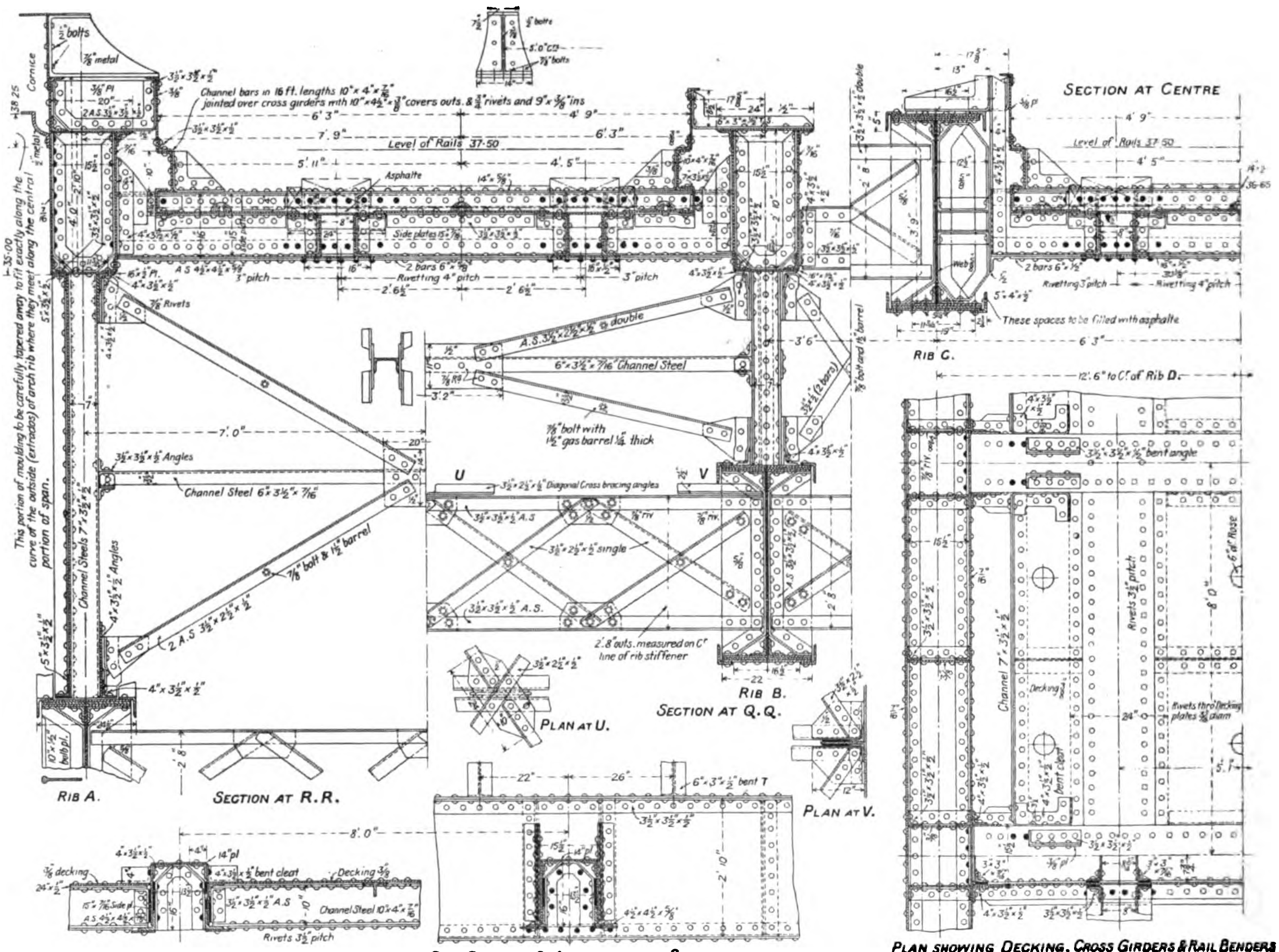
In the bridge of 1859 there are a series of four practically independent arches. If a load be placed on one of these arches the adjacent arches should not participate in it to any appreciable extent as the amount of stress transmitted through the indiarubber washers of the expansion joint can only be very small.



Bridge of 1865.
Bridge of 1859



Note.—All rivets to be ⅞-in. diameter e cept where otherwise specified.
The pitch to be as shown or specified on the drawings.
Rivets shown black to be countersunk on the outside as required for erection or for bearing surface, as well as any others which may require countersinking at bearings.



SECTIONS THRO' CROSS GIRDERS SHOWING RAIL BEARERS & ATTACHMENT TO STRINGERS

PLAN SHOWING DECKING, CROSS GIRDERS & RAIL BENDERS

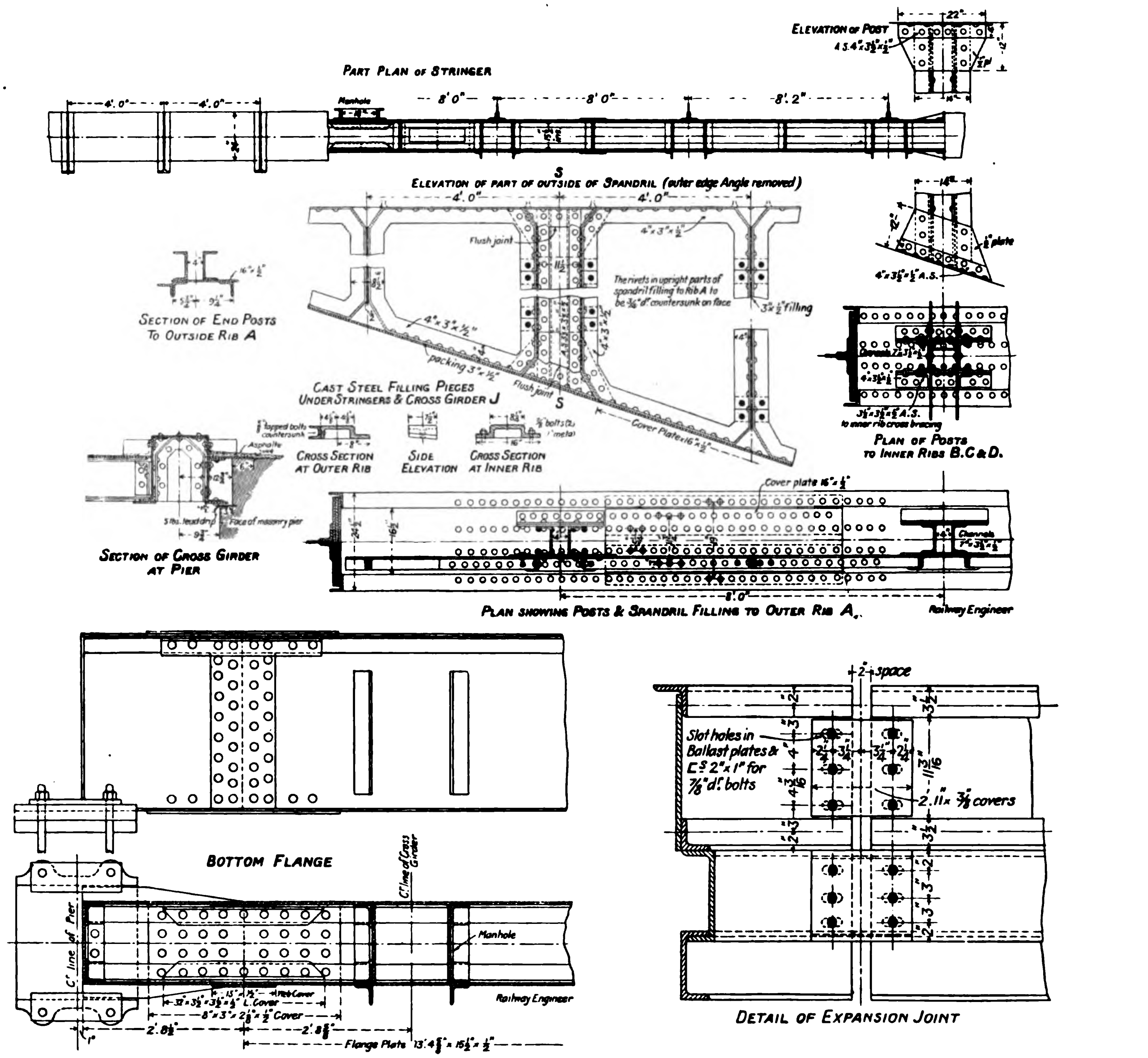
Widening of Grosvenor Pridge; London, Brighton and South Coast Railway.

This is proved by the fact that the deflection of the loaded arch was 0·76ins., whereas the upward deflection of the adjacent arches was only 0·12ins. It is even doubtful whether this rise of ·12 was due to the stress being transmitted over the pier.

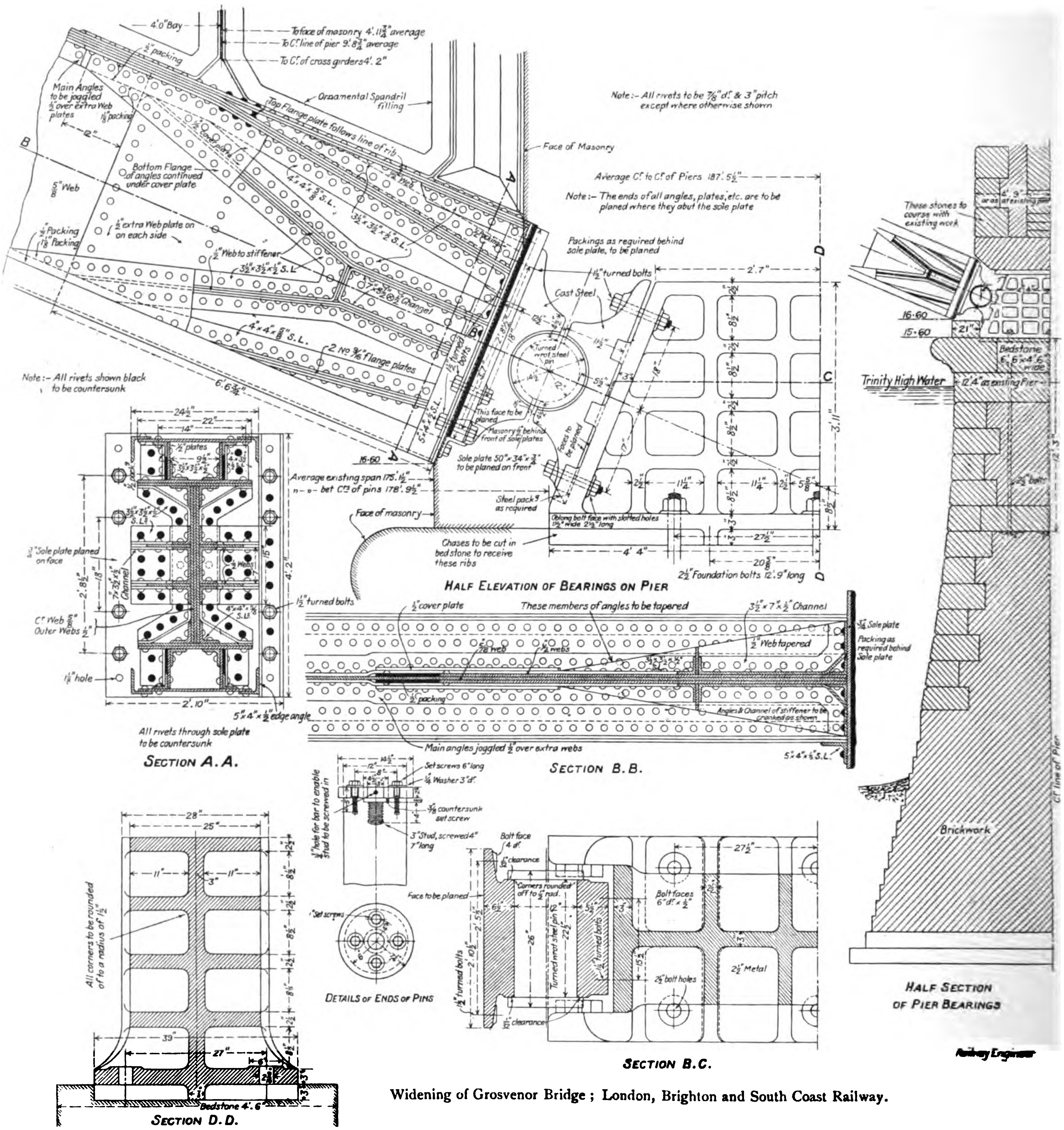
It is a well-known fact that all masonry structures have a certain amount of elasticity. The Vauxhall chimney at Liverpool has been known to swing something like nine inches in a high gale of wind. Supposing a certain amount of elasticity existed in the piers a movement of only 0·06ins. in the pier, due to the thrust from the loaded span, would account for the rise of 0·12ins. which was observed. The bridge of 1865 was designed on the assumption that the piers had no lateral stability, consequently the whole of the horizontal thrust from a loaded span might have been transmitted to the adjacent arches through the continuous stringer girders. The Board of Trade test, however, proved the stability of the piers, and that the precautions necessitated by the assumption of their instability were not justified, as for practical purposes the deflections were the same in both designs.

With regard to the second bridge Mr. (now Sir) Benjamin Baker, before the Inst.C.E., said that the influence of changes of temperature were very important and might attain 3·5 tons per sq. in. from this cause alone. However, the experience of the two bridges has proved that however remotely divergent were the principles which weighed with their designers they have done their work very well up to the present time. There is less ambiguity as to the amount of work done by various portions of the structure in the 1859 bridge, and this consideration carried a great deal of weight with Mr. Morgan in deciding on the decision for the new one. Thus on the completion of the second bridge the total combined width was 132ft. 6in. between parapets, and the number of lines carried was seven, viz., five narrow and two mixed gauge. Two platforms were included, one 24ft. and the other 12ft. wide, in connection with the stations at either end.

The series of drawings which by the kindness of Mr. Morgan are given on pp. 285-8 show very clearly the details of the construction of the new portion of the bridge. They are fully dimensioned, and with the notes on them are self explanatory. The photographic views in the last issue of *The Railway Engineer* show the staging and method of erection.



Widening of Grosvenor Bridge: London, Brighton and South Coast Railway.



Widening of Grosvenor Bridge; London, Brighton and South Coast Railway.

Protection of Bridge Floors against Corrosion.

In what, for comparison, may be termed the "Barbaric" or "Pre-historic" days of the early railways, constructed sixty or seventy years ago, a good many bridge floors were constructed of eight, ten, or twelve inch timbers laid close together, through the joints of which water was soon found to percolate in a very free and easy manner. Later on, and within the memory of living men, the rural and urban authorities had a fine time in wrangling with the railway companies in order to induce them to put up corrugated iron sheeting underneath the bridges, in order to protect the surface of the roadway below the bridge from damage, and consequent to constant and expensive attendance and repairs.

Still later on, however, the railway companies themselves found that it was extremely undesirable from a maintenance point of view to allow water to remain on their bridge floors. It was found that after rain dampness remained and the timbers quickly rotted and required renewal; the iron of the girders upon which the floors rested became pitted from corrosion, and in these cases, when the corrosion had gone too far, there was nothing for it but to renew or patch the ironwork at considerable trouble and expense, and great hindrance to

traffic. The "water bogey" then became of manifest importance as touching the interest of the railway companies themselves.

Iron plated floors—flat, buckled and curved—and jack arch floors came in and superseded the timber floors, and in some enlightened parts of the world even reinforced concrete floors have entered the field (fig. 5), but the old bogey still survives and is yet in evidence, and even in the twentieth century the question of the effective protection of bridge floors against rust is still not settled, but remains a pressing matter for all railway and bridge engineers. Where cinder ballast is used under the railway sleepers the rain water becomes impregnated with chemicals capable of rapidly destroying any ironwork to which it gains access, and the difficulty of maintenance is still further accentuated under such circumstances.

If the old-fashioned level bridge floor of close timbers is made comparatively watertight by tightly caulking it between the joints and then by the running of pitch over the surface, some provision must of necessity be made to get the water away either down the back of the abutment walls or into gutters underneath the bridge, or otherwise the bottom of the ballast will be constantly wet. In some cases a more elaborate treatment of the wooden floor has been tried by first carefully grading the upper surface and then adopting a two or three ply covering of felt or several thicknesses of brattice cloth laid down between successive layers of hot asphalte. Over this covering was placed another coating of asphalte mastic or some other material to prevent the puncturing of the waterproofing by the sharp hard ballast and the tools of the men engaged in keeping up the line. The next trouble was that leakage took place at the gussets and against the web of the girders and fillets of wood had to be fixed around all such places of leakage, and these in their turn required to

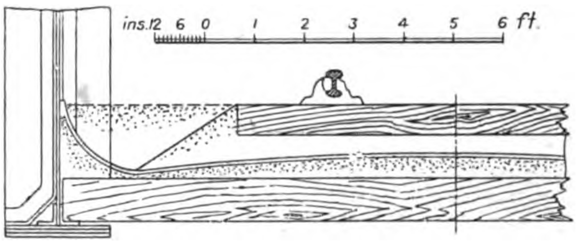


Fig. 1.

be protected by waterproofing and hot ashpalte. A thin layer of concrete to turn the water has been tried on the top of the level creosoted planking, say one inch in thickness at the lowest and three inches thick in the highest part, covered with a coat of asphalte ¼in. or ½in. thick applied hot (fig. 1), but this also required to be protected from damage by hard ballast and workmen's tools. This, however, was not always satisfactory; the asphalte did not adhere to the concrete, and it did not adhere either to any ironwork to which it might be applied. It was discovered that in many cases the cement concrete had not been thoroughly dry when the asphalte was applied to it, and that the oil or paint coating on the ironwork hindered the adhesion of the asphalte.

But in the natural course of things close plank floors soon became out of date and were superseded by floors made in the form of iron troughs, usually arranged at right angles to the direction of the line (fig. 2). Sometimes the sleepers were placed in the troughs, but at once difficulty was found in the necessary tamping of the ballast under the sleepers, there being no access for the tools of the platelayers either endways or sideways under the sleepers when laid in the troughs. It is eminently desirable therefore that the permanent way shall be laid well above the troughs, which in such circumstances, of course, require to be filled with a material that will both support the weight of the trains and also exclude the wet.

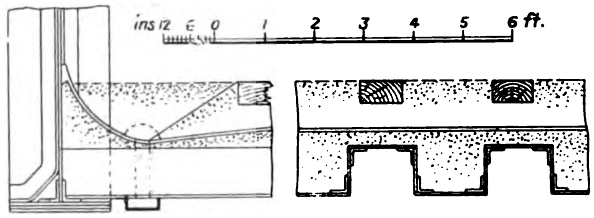


Fig. 2.

Asphalte mastic has been used for the filling in of such troughs, the mixture being composed say of one of asphalte to four or five of limestone screenings. Previously to the filling in the ironwork is covered with a thin layer of pure asphalte applied whilst hot, the vertical surfaces being covered by the process of mopping. The mastic is then filled in and carried over the tops of the troughs, is crowned in the centre of the bridge and sloped down to the sides, where gutters are formed, leading either to the back of the abutment walls or laid to drain to drip pipes, which in their turn convey the water down into gutters fixed underneath the superstructure of the bridge. On the asphalte mastic a ¼in. layer of pure asphalte is applied.

With this arrangement, however, it is found that the mastic in cooling draws away from the sides of the troughs, and even when the sides of the troughs are filled in with hot asphalte between the mastic and the ironwork subsequent cooling occurs, and fine cracks are found that let the water through and allow it to remain just in the place where it is most undesirable, that is, against the ironwork. In this case the whole object of the filling is defeated, that is, the protection of the steel and the provision of a solid mass in the troughs with such close adherence to the steel that it shall be watertight. Purposely-made mastic blocks have been used for the troughs, the width of the block being just sufficient to fill the space between the rivet heads of the troughs and these were set in place after the usual ¼in. coat of pure asphalte had been applied to the steel. Pure hot asphalte was poured down the sides of the mastic blocks, but it was found that the cool blocks again absorbed a considerable portion of the hot liquid, and it was not by any means certain that all the voids, especially underneath the blocks and between them and the floor of the troughs, had been properly filled up. The difficulty yet remained of attaching the first thin layer of asphalte to the iron, and although concentrated lye was used for the removal of the shop coating of oil or paint the result was unsatisfactory.

In some cases the troughs were filled in with Portland cement concrete, in the proportions say of one cement to three of sand and three crushed stone, and a wire netting of No. 10 wire, 2ins. mesh, was laid upon this, costing about 2½d. per sq. ft. This wire netting was covered with cement mortar, say one cement to three of sand, laid 2ins. thick in the centre and sloping downwards to the sides, where it was about 1½ins. thick. Some reinforcing of this kind is imperatively necessary in the cases of bridges with continuous floors over intermediate supports, especially immediately over

such points of support, since if this is not done the cement flooring and the asphalte coating will certainly crack over these parts of the structure.

In other cases sheets of saturated felt or brattice cloth are laid between successive layers of hot asphalte over the concrete, perhaps two or three layers of felt between the layers of asphalte, the felt being gnerally laid from the lowest point upwards, each joint being overlapped and laid down over the adjoining width with hot irons. On the top of this a layer of at least ¾in. thick of cement is laid to protect the waterproofing from injury due to ballast, tools, or weather influences.

Sometimes the top of the concrete is painted over with a mixture of asphalte and benzine, after which hot asphalte

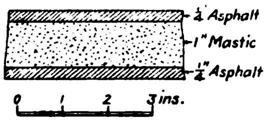


Fig. 3.

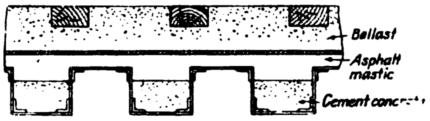


Fig. 4.

is poured to a thickness of ¼in. This layer is then followed by a 1in. thickness of asphalte mastic made in the proportions of one asphalte to four of limestone screenings (fig. 3), and upon this another layer of pur asphalte ¼in. in thickness, sand being usually sprinkled over the top to harden the surface.

Sometimes the procedure is to clean the surface of the steelwork and then paint it with hot asphalte and benzine, and upon this to lay a ¼in. coat of asphalte, thoroughly mopping it against the vertical surfaces. The trough is then filled up to within say 3ins. of the top with Portland cement concrete, say one cement to six limestone screenings. When this is thoroughly set and dry the remaining depth of trough (fig. 4) is filled in with mastic, and this upper layer is carried well over the tops of the troughs and laid to fall for the water, this being in turn covered with a ¼in. or ⅜in. layer of pure asphalte.

The surface of the ironwork is not always cleaned before the first application of the asphalte, and it is even now considered doubtful by some engineers whether the adhesion is not just as good when the cleaning is not attempted. It is very often found indeed that no matter what care is taken, the asphalte can be peeled off the ironwork like a sheet of paper directly it becomes cold.

If the steelwork is rusty, asphalte has absolutely no adhesion to the metal at all, and if it is applied to the shop coat of oil or red lead there is very little better result. It is better when the shop coat is covered with liquid asphalte, and when the shop coat is burned off by pouring benzine over it and setting fire to the benzine the result is again slightly better. With clean bright steel, however, the adhesion of the asphalte is far better than in any of the other cases, but to ensure this condition being perfectly fulfilled it would be necessary to employ the sand blast over all the surface of the metal, which is practically out of the question. If the metal is rubbed with wire brushes or scraped the result is not much better. Burning benzine over oil or paint has been found in some cases to have very little effect except to soften the coating, and repeated burnings by this process would become very expensive. Concentrated lye and lime has been tried for the removal of the coating with some success, but some of the lime will inevitably remain on the iron, especially near the rivet heads, no matter how it is washed off, and this is, of course, injurious. Perhaps the best practical method is to make asphalte very liquid by pouring hot asphalte into benzine and painting this over the shop coat on the metal. In this case the benzine evaporates, but leaves a thin layer of asphalte on the metal, and with two coats a layer of perhaps 1-16in. will be found upon the surface.

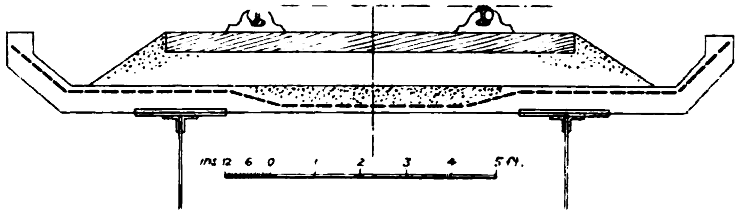


Fig. 5.

The requirements as regards the asphalte damp proof covering are that it shall be sufficiently hard to resist the weight upon it without spreading, but at the same time that it shall have ductility enough not to crack under tension or to tear apart under changes of temperature.

Concrete is without doubt the best material with which to fill in the troughs of railway bridges, but the top surface will not keep out the wet unless it is covered by a waterproof coating. In all cases, as we have said, expanded metal or wire netting should be used to prevent tearing away over the intermediate supports of bridge floors, but perhaps a series of small rods, ¼in. to ⅜in. in diameter, parallel to the main girders, could be used in such places with better advantage and economy. Where felting or brattice cloth is used to cover the concrete it requires to be protected either by a neat cement layer, say 2ins. in thickness, or by a course of bricks laid flat and grouted with either cement or asphalte.

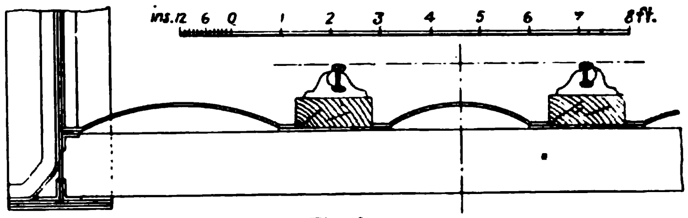


Fig. 6.

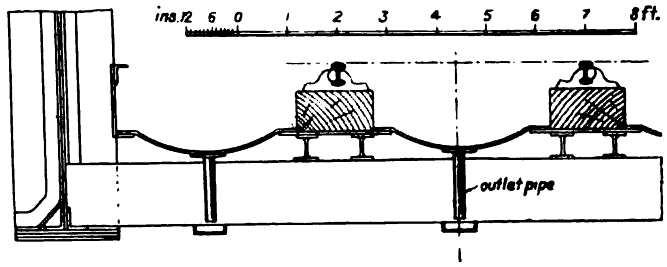


Fig. 6.

Preferably only the best of asphalte should be used for the purposes named, free from coal tar or turpentine, and the specification should demand that it shall not volatilise more than one per cent. under a temperature of 450° Fahr. for 10 hours. It should not be affected by a 20 per cent. solution of ammonia, or 25 per cent. solution of sulphuric acid, a 35 per cent. solution of muriatic acid, nor by a saturated solution of sodium chloride. It should not flow under 212° Fahr., and should not become brittle at 15° Fahr. below zero.

When hot asphalte is applied to metal the ironwork should be heated by a layer of hot sand, which is, of course, swept back as the hot asphalte is applied. The asphalte should be heated before application to 450° Fahr., and the sand and

screenings laid upon the work should be quite free from earth and dirt, and should also be applied hot.

Of course ballast is not used on all railway bridges. In many cases it is found necessary to use longitudinal timbers, 16ins. or 18ins. in width, underneath and parallel to the rail,

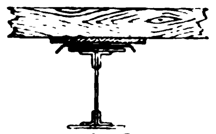


Fig. 8.

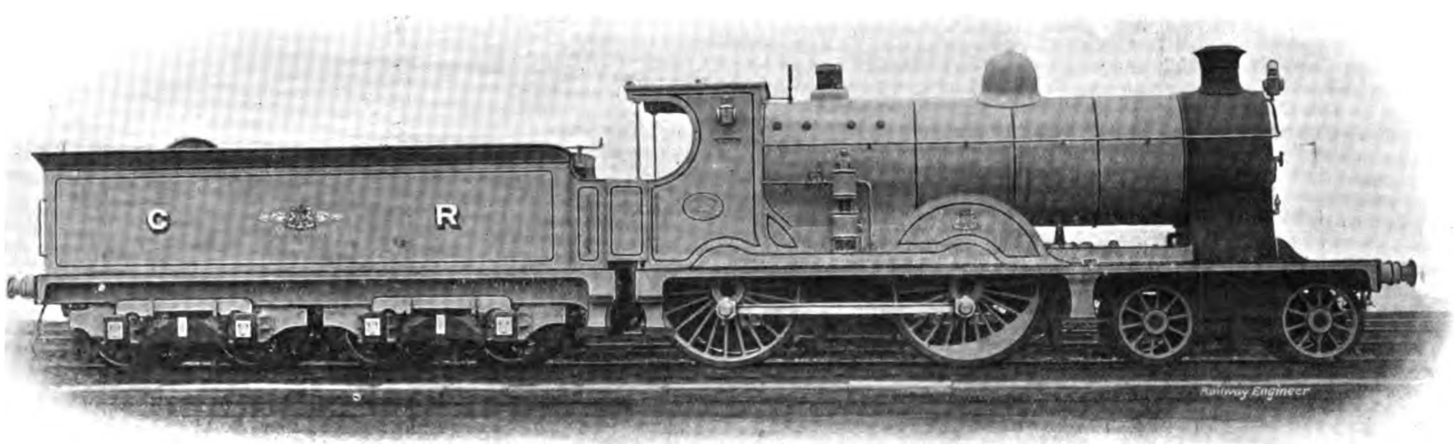
and in most of these cases the timbers rest directly on the ironwork of the bridge without any intervening thickness of ballast. In the "ancient" days of bridge construction, where floor plates were first used they were made to curve downwards towards the sides of the timbers (fig. 6) in a way that must have been most deleterious to the timbers. Later on it was discovered that it was equally easy to place the curved floor plate with its concave surface upwards (fig. 7), so that the water that fell on the bridge was collected away from the timbers instead of being directed to fall towards them.

In this case outlet pipes are required to be tapped and screwed into the floor plates at distances of about 5ft., or, better still, at whatever points water is found to lodge.

Where girders lie under timber floors, and especially in the case of cross girders, some amount of protection may be given to the girders by covering them (fig. 8) with a layer of zinc or lead turned down over the edges, as shown in the figure, but in this case it will be necessary to introduce a layer of felt between the girder and the zinc covering to obviate any possible chemical or galvanic action and to preserve the zinc from the rivet heads, and also to add another covering, say of boards, say 1in. in thickness, carefully jointed and placed over the zinc to protect it from the pressure of the floor above it, and from wet.

New 4—4—0 Type Locomotives Caledonian Railway.

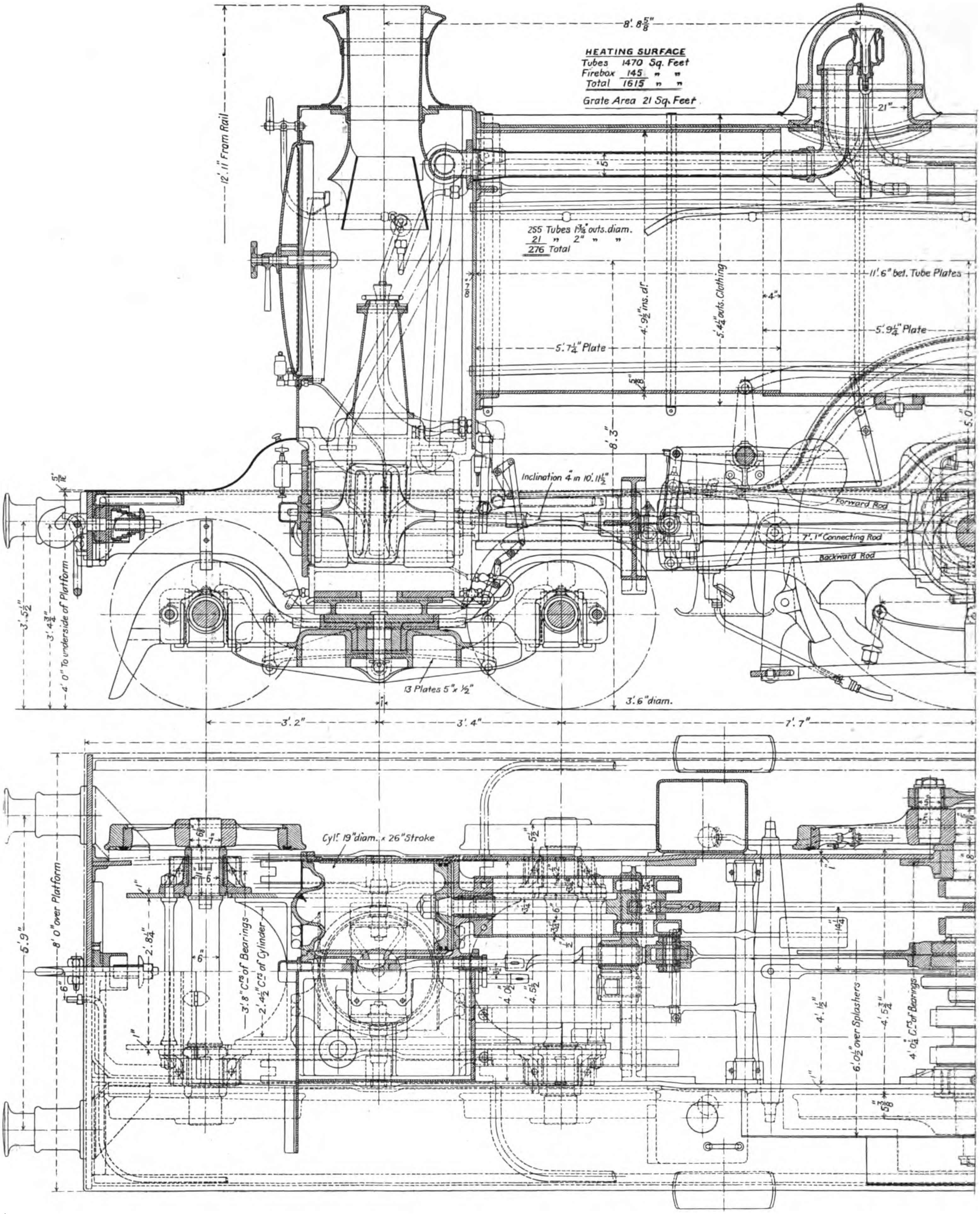
Since his appointment to the position of chief locomotive engineer on the Caledonian R. in 1895, Mr. J. F. McIntosh, M.Inst.C.E., has introduced several types of locomotives, both for passenger and goods service on that line, and in each case the engines have been noteworthy for simplicity of design combined with ample boiler power, whilst the cylinder capacity, although in all cases sufficient, has been kept in proper ratio to the steam generating power of the boiler allowing for the maintenance of a reserve on the part of the latter to meet the most stringent conditions of working. In his latest class of 4-4-0 express passenger engines, one of which we illustrate herewith by photograph and sectional drawings, Mr. McIntosh adheres in the fullest sense to the characteristics referred to above, and, as will be gathered from the annexed drawings and the dimensions which follow, the size and arrangement of the boiler are such as to ensure an adequate supply of steam being at all times forthcoming for use in the somewhat moderately proportioned cylinders employed, which, taken in conjunction with the fact that the diameter of the coupled wheels is kept down to 6ft. 6ins. on tread, has the effect of providing an unusually powerful engine, of straightforward design, and arranged upon a total wheelbase of 23ft. 10ins., of which 9ft. 9ins. separates the centres of the coupled wheels.



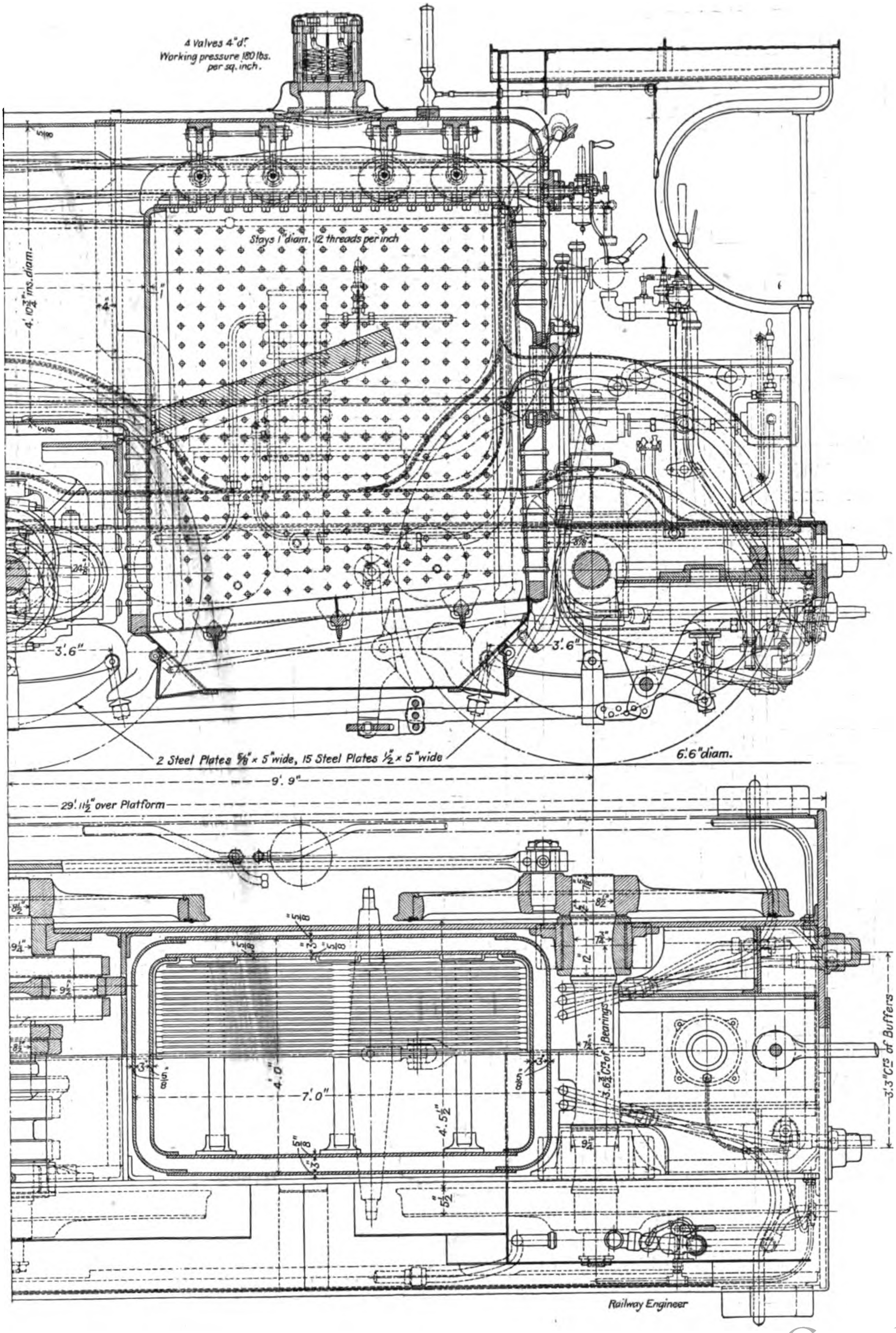
New 4—4—0 Type Express Locomotive; Caledonian Railway.

These engines, which constitute the fourth successive development of 4-4-0 passenger locomotives which Mr. McIntosh has designed for the Caledonian R., are substantially of the same design as those of the famous "Dunalastair" class put to work in 1896, with which the series, culminating in the engines now under notice, may be said to have been started. The development has been wholly one of dimensions, and in this latest series proportions have been reached which in some respects may be regarded as maximum for the British loading gauge.

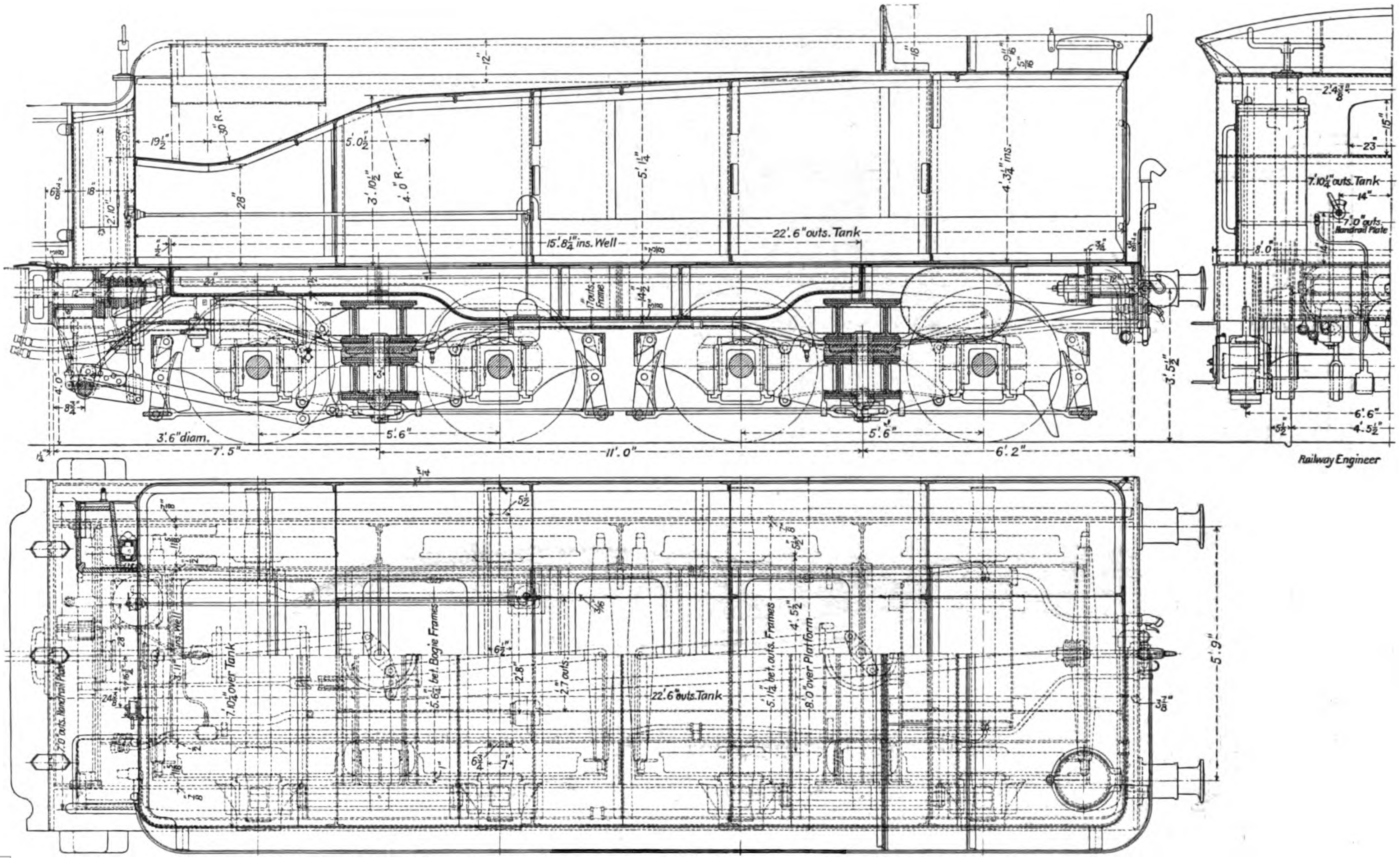
The engines are engaged in working heavy express passenger trains on the Caledonian main line, including the West Coast corridor vestibule trains, between Carlisle, Glasgow, Edinburgh, Perth, Dundee and Aberdeen. On these services trains equal to 19 to 21 coaches and weighing from 350 to 400 tons are frequently made up and the speeds rule between 45 and 50 miles per hour. On the southern section assistance is only taken on the Beattock incline, which rises 600ft. in 8 miles and is 9¾ miles long, with an average gradient of 1 in 75. The 4-6-0 type express passenger locomotives Nos. 49 and 50, designed by Mr. McIntosh, which have 21ins. by 26ins. cylinders and three pairs of 6ft. 6ins. diameter coupled wheels, are able to work these trains single-handed over the incline, but this is not, of course, to be expected with the four coupled engines, in view of the loads and average speeds required.



New 4—4—0 Type Express Locomotive ;



Caledonian Railway.



4,300 Gallons Tender; Caledonian Railway.

The principal dimensions of the "140 class" locomotives, as illstrated are:—

Cylinders, diam.	19ins.
Piston stroke	26ins.
Coupled wheels, diam	6ft. 6ins.
Bogie wheels, diam.	3ft. 6ins.
Wheelbase, fixed	9ft. 9ins.
Wheelbase, total	23ft. 10ins.
Total heating surface	1,615 sq. ft.
Working steam pressure	180 lbs.
Grate area	21 sq. ft.
Weight of engine in working order	54 tons, 7½ cwt.
Adhesion weight	35¾ tons

The tender, of which drawings are also annexed, runs upon two four-wheeled bogie trucks, and has capacities for 4,300 gallons of water and 4½ tons of coal. The total weight of engine and tender in working order is 107 tons 7 cwts.

C.S.L.

Lagos Government Railway, 1904-5.

THE report of the general manager, Mr. F. Bedford Glasier, of the Lagos Government Railway, for the year ended 31st March, 1905, states that :—

The special ballasting was vigorously pushed forward. The £6,000 sanctioned was utilised before the close of the financial year and a further £629 was spent against the further sanction of £10,000 communicated under Secretary of State's despatch No. 56, February 13th, 1905. It was at first considered that this expenditure might be incurred gradually, mostly through the agency of the maintenance department, and by the intermittent labour of the regular maintenance gangs. But the condition of the road on the lower section, where "selected material" instead of ballast had been so largely used during construction, indicated the desirability of a more vigorous prosecution of the work, especially in view of the advancing wet season and its influence on upkeep. The engineers of the open lines had fortunately the expert advice of Mr. Bradford, resident engineer of the Oshogbo Extension, who had then just recently arrived in the Colony. It was decided, with the approval of Government, to lift the road 6 inches, and to relay it on stone ballast. This work is now in hand and is making satisfactory progress. A distinct improvement in easy running is already noticeable over the reballasted section.

The total expenditure to the 31st of March last on the Iddo Wharf Extension amounted to £28,033. This work continued to make satisfactory progress during the year, and the expenditure, measured by work done, falls within the limits of the sanctioned estimate. It is expected the wharf will be sufficiently advanced to admit of being utilised for public traffic by September, 1905, if not earlier. In January, 1905, Mr. Woodburn, the bridge engineer in charge of the Iddo Wharf Extension, assumed control of the capital works at headquarters now in progress. The general manager desires to place on record his appreciation of the valuable assistance he has received from Mr. Woodburn in engineering matters, and of the satisfactory manner in which that officer has performed his duties on the railway.

A comparatively large sum has been paid for land adjacent to the headquarters location in order to effect the removal of the insanitary native huts in close proximity to the railway staff quarters.

The sanction of the Secretary of State was received in December, 1904, to the commencement of operations on the construction of the extension of the railway to Oshogbo, about 70 miles. The survey party, with instructions to fix the final alignment, arrived in December last and were followed shortly after by Mr. W. Bradford, the resident engineer, and his staff. To the end of June, 1905, 24 miles of track are reported to have been staked out, while the earthworks are being pushed forward. A separate departmental staff was at first deemed necessary for construction purposes, but it has since been considered desirable to place the accounts department under the supervision and direction of the open lines chief accountant. It is probable that it will be found equally advantageous to utilise, in like manner, the experience and local knowledge of the other open lines departments for construction requirements. The existence of a fully equipped staff competent to undertake the proper movement of materials and the supervision and working of the rolling stock employed on construction will probably render unnecessary any large expenditure on separate establishments for purely temporary purposes.

In accordance with previous instructions of Government the last half-yearly report was for the six-monthly period ended September, 1904, to correspond with the official year. This was the first report on the working of the railway compiled for the financial half-year, all previous reports having been, in accordance with the usual custom of railways, for the calendar half-years. It is, however, understood that from January 1st, 1906, the Colonial Estimates will be framed for the calendar year, and hence, the railway reports will consequently revert to the calendar periods.

The Secretary of State, having decided that the reports on the working of the railway need only be annual, and not half-yearly as previously, the remarks in the present report apply to the 12 months ended March 31st, 1905, compared with the calendar year 1903. The accounts and traffic statistics now presented are for six months only, the figures pertaining to the first half of the past financial year having been previously reported for that period. In due course, the ordinary comparisons will be made for similar periods, so that the relative results may be more usefully considered. The figures for the official year 1904-05 are now contrasted with the calendar year 1903. They thus relate to dissimilar periods, and to that extent are vitiated by seasonal and other differences.

The general results of the year ended March 31st, 1905, are shown in the following table in comparison with the total of the two half-years 1903 :—

	Calendar Year, 1903.	Financial Year, 1904—05.	Increase.
Gross earnings ...	£51,259	£60,336	£9,077
Per open mile ...	408	481	72
Per train mile ...	0	0	0
Working expenses...	45,863	53,394	7,531
Per open mile ...	365	425	60
Per train mile ...	0	0	0
Net earnings ...	5,396	6,942	1,546
Per open mile ...	43	55	12
Per train mile ...	0	0	0

While there is an increase in expenditure of 17½ per cent. per open mile and 8½ per cent. per train mile, the income has also increased by 17½ per cent. and 9½ per cent. respectively, giving an increase in net earnings over 1903 of £1,546, or 28½ per cent. on the average receipts per open mile and 18 per cent. on the average per train mile. The additional cost of working is wholly the result of the increased cost of maintenance of way and works and the completion of the construction of the railway, as explained in the portion of this report relating to expenditure. Judged on the basis of volume of traffic handled, the expenditure for running charges shows a reduction during the 12 months ended March, 1905.

The total receipts show an increase of £9,077, or 17½ per cent., but there was a falling off in the coaching traffic for the year of £999. The number of passengers was 116,267, an increase of 16,203. This traffic produced a revenue of £13,941, a decrease of £321.

The average results of working the coaching traffic are :—

	Per train mile.		Per vehicle mile.		Per unit mile.	
Year ended	Dec. 1903. d.	Mar. 1905. d.	Dec. 1903. d.	Mar. 1905. d.	Dec. 1903. d.	Mar. 1905 d.
Average receipts .	97·29	101·94 ...	13·18	13·20 ...	.90	·91
„ cost ...	99·90	107·20 ...	13·53	13·85 ...	·93	·96
„ loss ...	2·61	5·26 ...	·35	·65 ...	·03	·05

	Year ended Dec. 03.	Mar. 05
Average number of passengers in a train ...	107·62	111·45
„ „ in a vehicle	14·58	14·43

It will be seen that the passenger traffic continues to be worked at a loss. This is more particularly so in the case of first class, which only contributes an average of 2¼ passengers, or under 30s. a train. Had each first class compartment been filled with goods freight, the receipts would have been at least sixfold. The continuance of three distinct classes is, therefore, a matter for consideration, and their retention would apparently involve the first class fares being enhanced to cover the cost of working the traffic. The first class fare on this railway was increased to 3·4d. a mile on January 1st, 1905, but is still below the fare on adjacent railways. The Gold Coast Railway charges 5d., the French Guinea 4·8d., and the Kayes Niger 4·2d. a mile.

The striking feature of the goods traffic is that public merchandise carried has increased 41½ per cent. in weight and 33 per cent. in receipts. This is very satisfactory, for at 16 out of the 19 stations the traffic has increased.

The average results of working the goods traffic are:—

Year ended	Per Train mile. Dec. 1903. d.	March 1905. d.	Per Ton mile. Dec. 1903. d.	March 1905. d.	Per Vehicle mile. Dec. 1903. d.	March 1905. d
Average receipts	105·95	113·83	2·63	2·92	16·28	17·56
„ cost...	86·50	92·40	2·11	2·37	13·55	14·25
„ profit...	19·45	21·43	·52	·55	2·73	3·31

	Year ended Dec. 1903.	March '05.
Average No. of tons in a train ...	40·22	38·94
Average No. of tons in a vehicle ...	6·18	6·00

The decreased average of loads per train and per vehicle is due to the larger quantity of cotton handled during the latter period. This traffic has hitherto been carried by weight and not by measurement. The density of the bales, as now pressed, leaves much to be desired.

The work done by the railway is indicated by the following figures:—

	Year ended Dec. 31, '03.	Mar. 31, '05.
Train miles	118,299	126,709
Vehicle miles	809,679	884,088
No. of passengers	100,063	116,267
Tonnage of goods	24,529	34,719
Unit mileage	4,911,934	4,593,366
Ton mileage, goods...	2,922,620	3,396,776
*Gross ton mileage	17,805,744	19,112,912

Receipts per	£ s. d.	£ s. d.
Average open mile	408 8 9·2	408 15 1·7
Average train mile	0 8 7·9	0 9 6·3
Average passenger mile ...	0 2 5·4	0 2 4·7
Average ton of public goods ...	1 5 11·9	1 3 10·3

*Freight and dead weight.

The increase in maize traffic has been satisfactory. In 1902 the traffic was only 144 tons, which produced £79; in the year 1904-5 it was 1,523 tons, and the receipts £702.

To promote agriculture and to develop this industry the freight on the railway has been placed at the very low figure of 10s. 6d. a ton from any station to the coast terminus for full truck loads. The steamship charges are, however, still maintained at a relatively high figure, and it is to be hoped that the repeated representations of the leading merchants in this connection will receive the consideration they deserve from Messrs. Elder, Dempster and Co.

The working expenses absorbed 88·4 per cent. of the gross earnings (compared with 89·47 per cent. for 1903), and were distributed as follows:—Way and works, 21·31 per cent.; loco. car and wagons, 41·31 per cent; traffic, 16·64 per cent.; general, 20·74 per cent.

The expenses have averaged £425 per mile open and 8s. 5d. per train mile, as compared with £365 and 7s. 9d. during the year 1903.

In regard to fuel, it is gratifying to be able to record that, although the result does not affect the figures for the year under review, the continued agitation for a reduction in the price of coal has, at last, been instrumental in bringing that very important item of expenditure down to 32s. 6d. a ton. Early in the present year, tenders were invited by Government, and a contract was entered into with Messrs. Elder, Dempster and Co., the previous suppliers, with effect from April, at the figure named, showing a reduction in the price of fuel of 12s. 6d. per ton, or 28 per cent. The change to liquid or other fuel which was contemplated is now no longer a matter demanding immediate consideration. The recent action of Government, therefore, removes one of the heavy disabilities which prevented the economical movement of traffic on this railway.

Indigenous Skilled Labour.—In a former report, mention was made of the approved scheme for the successful training of native youths as artizans. The necessity of replacing, at the earliest possible date, a large proportion of the expensive European skilled labour, in the railway shops, by adequately trained native artizans has often been referred to, and arrangements are now being brought to a head by which some native youths will be sent to England, and placed in the workshops of engineering firms, for a suitable period, as bonded apprentices. There is good reason to hope that the issue of the experiment will be sufficiently successful to warrant other youths being sent, after a period of probation in the shops here, to undergo the same training in England, and the system may thus be extended in the course of years until the expensive European staff in this department may be reduced to the small number sufficient for expert supervision and superintendence only.

The length of the track maintained was 132 miles 28 chains, of which 6 miles 68 chains are sidings. The cost per mile for maintenance was £56 17s. 5d.

The rolling stock consisted of 5 light and 12 heavy locomotives, 28 carriages and 132 wagons.

Bow to East Ham Widening; London, Tilbury and Southend Railway.—1

By Chas. S. Lake.

Those who are interested in the railway traffic problem in the vicinity of London, and especially those who are acquainted with the conditions prevailing within the suburban area, on the lines leading eastwards from the Metropolis, will find a study of the manner in which a complicated form of the problem referred to has been solved on the London, Tilbury and Southend R., by means of important widening works which have recently been completed within the London suburban district.

In order that the scope of the undertaking which has now been carried to a successful issue by the company's Chief Engineer, Mr. James. R. Robertson, M.Inst.C.E., and those working under him, may be properly appreciated, it will be necessary to briefly outline the state of affairs which existed on this railway prior to the commencement of the Bow to East Ham widening works, which form the subject of the present article.

Although the trains of the London, Tilbury and Southend R. have direct access to Fenchurch Street Station, the company's main line actually commences at Gas Factory Junction, some 2¾ miles distant from the terminus, where a junction is effected with the Blackwall R., which is leased to the Great Eastern R., and over which the Tilbury and Southend trains travel, by the exercise of running powers, to the terminal station at Fenchurch Street.

It will not be necessary for present purposes to refer back further than the date upon which the Whitechapel and Bow R. was opened, viz., June 2nd, 1902. The completion of this undertaking, which is owned jointly by the Tilbury and the Metropolitan District Companies, enabled the District R. to run their trains through Whitechapel, which till then had been their terminus, on to the L.T. and S. main line at Campbell Road Junction, from whence the service was extended to East Ham, and (in the case of a few trains) to Upminster.

About ½ mile beyond Campbell Road Junction, at a point immediately west of Bromley Station, a branch of the North London R. from Bow joined the L.T. and S. R., and the

former company's trains also used the same rails as far as Plaistow Station, where the service terminated.

To further complicate matters, the Great Eastern R. Co. then (as now) maintained a frequent service of trains between Fenchurch Street, North Woolwich and the Royal Albert Docks, and which in the course of their journey passed over the L.T. and S. lines from Gas Factory Junction to Abbey Mills Junction, the latter being situated about ½ mile east of Bromley Station.

volume of traffic with which the owning company had to deal, and the constant delays to which their trains were subjected, it was decided that the line would have to be doubled as far as East Ham, a distance of about 3¾ miles from Campbell Road. The necessary Parliamentary powers were obtained in 1898 for the portion between Plaistow and East Ham, and in 1902 for the portion between Campbell Road and Plaistow. Districts became developed and traffic increased, and further consideration of the traffic problem deter-

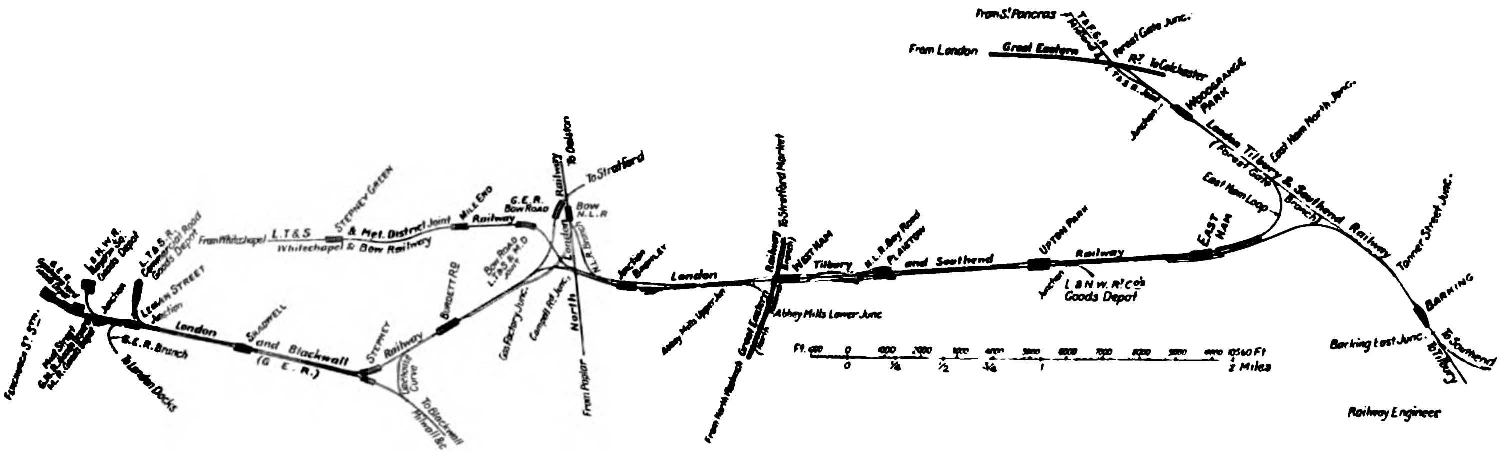


Fig. 1.—Diagram of Lines and Junctions between Fenchurch Street and Barking.

Therefore, in all four separate companies used the single pair of lines, which then constituted the L., Tilbury and S. main line, through one of the most congested suburban areas near London. These comprised the L.T. and S. trains, the Great Eastern trains to and from Abbey Mills Junction for Woolwich, the District trains from Campbell Road Junction to East Ham and Upminster, and the North London trains between Bromley and Plaistow. (See fig. 1.) In addition the last-named railway worked a heavy goods traffic from the L. and North Western, the Great Western and other railways

mined the directors to get the sanction of Parliament to the widening from East Ham to Barking, which was obtained in 1904.

The widening works carried out under these powers have recently been completed between Campbell Road and East Ham, and by enabling one class of traffic to be separated from another have afforded the relief so urgently required.

Furthermore, the completion of four lines to East Ham marks the advent of electrical trains on the District R., and the Tilbury Co., by the work they have done, are now in the

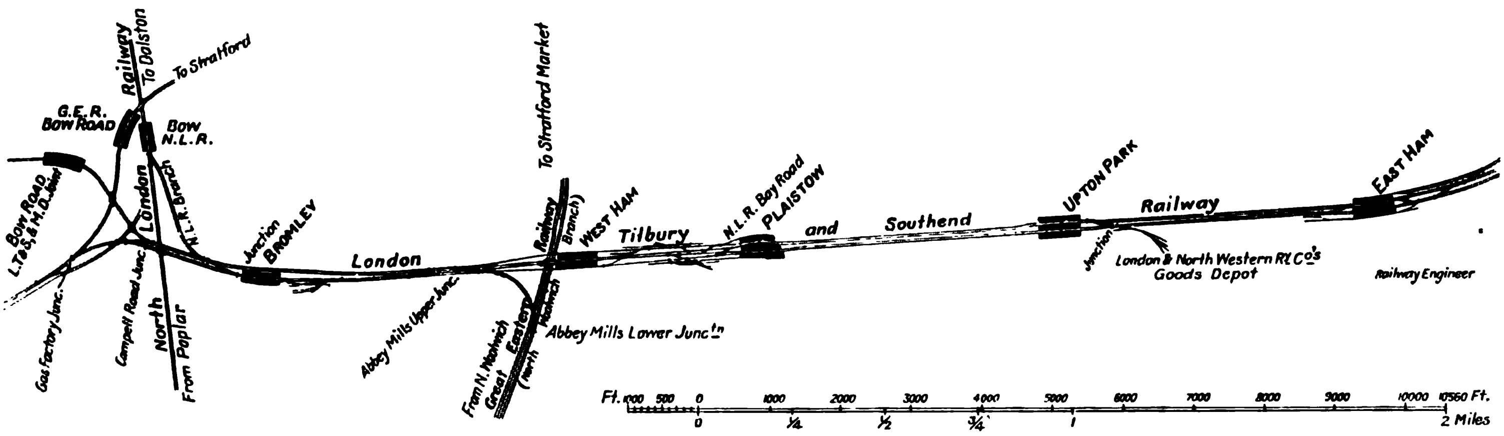


Fig. 2.—Diagram of Widened Portion of Lines; Bow to East Ham, L. T. & S. Ry.

through to Plaistow, where the exchange is made with the L.T. and S. R. and to the L. and N.W. R. Co.'s depôt at Upton Park. The Tilbury and Southend Company also worked a number of goods trains between their system (including Tilbury Docks) and their chief goods depôt at Commercial Road, London. Add to this the fact that many of the Tilbury Co.'s trains were expresses, for which long intervals between slow ones had to be allowed, and it will be readily recognised that under these conditions the observance of punctuality by the various services became a matter of the greatest difficulty, if not impossibility, and in view of the ever increasing

fortunate position of possessing one pair of roads for steam and the other for electrical traction.

In 1902 the work of widening (see fig. 2) was begun at East Ham, but in order to simplify this description it will be advisable to consider the scheme as a whole, commencing at the London end, without reference to the order in which the various sections were completed. The widened lines may be said to start at Campbell Road Junction, where, as before said the Whitechapel and Bow R. joins the London, Tilbury and Southend main line.

On August 1st last the two extra roads for their full

length were brought into use from this point onwards to East Ham, and the District Company's trains, instead of passing on to the down Tilbury main line at the Junction as heretofore, now remain clear of the latter by utilising the new down "local" line, which forms a direct continuation of that traversed in coming from Whitechapel to Bow.

In like manner the District trains running in the opposite direction utilise the new up "local" line, which is also quite distinct from those worked over by the Tilbury and Southend and other trains to Fenchurch Street, which are now considered as "through" roads to be kept as clear as possible for the fast and longer distance trains.

Fig. 3.—Campbell Road Junction, Starting Point of the Widened Lines.

The widened lines immediately after passing the point which marks their commencement are carried, together with the other portion of the railway, over Campbell Road Bridge (see fig. 3), and the level of Campbell Road has been lowered by 3ft. 6ins. in order to obtain the necessary headway.

A bridge of somewhat novel design with suspended girders over the footway, constructed at the time the Whitechapel

Fig. 4.—Bridge over the North London Ry.

and Bow Railway was made, had to be removed to make way for the new one, which is of plate girders, with brick jack-arches, the new abutments being faced with white glazed bricks.

Then comes the bridge over the North London railway and locomotive and carriage works at Bow. Formerly the L., Tilbury and S. R. was carried over here by a bridge of about 140ft. span, with three wrought iron braced bow-string girders (see fig. 4), the top members of which had a very ingenious combination of cast iron segments to take the compressive strains rivetted to the wrought iron flanges. The floor was of baulk timbers, on which rested the timber longitudinals carrying the rails.

This bridge, which had done duty (with some strengthening about 20 years ago) since March, 1858, the year in which the Bow to Barking Branch—as it was then called—of the L., Tilbury and S. R. was opened for traffic, has since been replaced by the present braced steel girder bridge, which came into use on July 10th, 1904. (See fig. 5.)

The new bridge, with the other bridges on the widening, will, accompanied by detailed drawings, be made the subject of a second article in the November issue of the *Railway Engineer.*

From Rounton Road Bridge, the actual starting point of the widening, a little to the west of Campbell Road Bridge (the existing girders and flooring of which were shifted bodily northwards in one night), to the North London R. Bridge, the widened lines are carried between the bridges on arches built of gault bricks faced with blue Staffordshire bricks, but beyond the latter bridge stock-bricks were employed for facing purposes.

Burdett Street is crossed by a steel bridge of 40ft. span, having centre and outside girders with steel trough flooring. From this point to the junction with the North London branch railway the line is carried on embankment, supported on the outside by a concrete retaining wall surmounted by a stock-brick parapet. The branch of the North London R. from Bow here joins the widening, which then crosses Devons Road by the bridge formerly used by the branch line only, and to which a new superstructure has been put by the Tilbury Company.

Beyond this point there previously existed a retaining wall following the course of the North London branch. At Bromley Station this wall, which formed the backing to the then down platform, has now been partially removed, and a

Fig. 5.—Bridges over N.L.R. at Bow. Bridge on left is for the Widening, Bridge on right replaces former bridge for old line.

new concrete retaining wall constructed. A double line of rails and a new platform behind it on land acquired from the Borough of Stepney Union has been added.

The alterations carried out at Bromley Station include the conversion of the old down single platform to one of the island type, for use in connection with the new up local line, whilst an additional platform has been provided for

passengers by the down local line trains. At the West or London end of the station access to the platforms from Devons Road has been provided, and a booking office also established here. A footbridge communicating with all the platforms has also been erected for the use of passengers near the west end of the station. The old awning over the down platform has been taken down and re-fixed over the new down platform, and a new double awning substituted in its place, whilst the signal-box which originally stood on the up platform, about midway in its length, has been removed, and a new one erected on the south side of the up through line at the London end of the station.

Fig. 6.—New Bridge over River Lea and Bow Creek, L.T. & S.R.

the work. The main booking office, which is located at this end of the station, has not been altered, but an approach to the new down local platform has been provided by means of a covered food-bridge and staircase.

From the point of its commencement at Campbell Road Junction to the east end of Bromley Station the widening is wholly situated on the north side of the railway. At the west end of the River Lea Bridge it is on the south. At about ¼ mile from the end of the platforms the River Lea, with Bow Creek adjoining, is crossed by means of a braced steel bridge (see figs. 6 and 7) of two spans of 200ft. each for the new lines, whilst the original lines are carried upon a bridge of the same span close alongside. The differences in in the construction of these bridges will be described in the next article.

The new bridge was brought into use on August 1st this year. By the evening of July 31st the new lines had been laid as far as possible up to the north and south sides respectively of the old double road (on which all the trains were then running) ready for the alterations to four roads to be made between the station and the bridge directly the traffic stopped for the night, only a few hours being available. On the night in question the old double lines were severed at a point 200 yards east of the station, the portion of them on the east side of the break being slewed to the north to join the new local lines on that side, and the other portion to the south, where they were connected up to the through tracks leading to the new bridge. The work of slewing the four roads and making the necessary connections was carried out in a few hours during the night, everything being completed and ready for the resumption of

Fig. 7.—Double Span Bridge over the River Lea and Bow Creek, L.T. & S.R.

This new signal-box is considerably larger than the old one, and contains 75 levers, as compared with 35 in the old box.

At the east end of Bromley Station St. Leonards Street is carried over the railway by means of a bridge constructed of steel girders with brick jack-arches. This bridge has been made 50ft. in width over the new lines to meet the future requirements of the London County Council, whose intention, presumably, is eventually to widen the street. The bridge carrying the road over the older portion of the railway remains at present as originally constructed, viz., 31ft. wide, and the extra width of the new portion has been fenced off until such time as the L.C.C. decides to perform its part of traffic on the following morning—an especially commendable piece of work.

After passing over the Lea and Bow Creek bridges the railway continues in a direct line to West Ham Station, about half-way to which is Abbey Mills Junction.

The level crossing which formerly existed at this point, and which gave access to the Gas Light and Coke Company's Works at Bromley-by-Bow has been removed, and a new accommodation road made under the railway with sunk approaches on each side, that on the north being formed between retaining walls supporting the railway on one side and a public road on the other.

Very little alterations were necessary to West Ham

Station, as its construction only dates from 1901, at which time the company had already decided upon the widening scheme. The two island platforms remain as originally constructed, but the two roads whch, under the original arrangement, branched off the main line at the east of the station and terminated alongside the outer platforms (and so were merely bay roads) have now become part of the widened lines, that on the north side being the down veyed from the pumping station at Abbey Mills to the outfall works at Barking. Considerable alteration had to be made to this bridge. A widening of it designed to meet the requirements of the railway company was first carried out by the Council for their own purposes, and after the sewage was diverted into the new conduits the old bridge was altered to give the same amount of room for the lines of rails to be laid under it. Originally it had one opening of 25ft., through

Fig. 9.—Staircase and Footbridge at Plaistow Station before re-building.

Fig. 10.—Staircase and Footbridge at Plaistow Station after re-building.

Fig. 11.—Plaistow Station from West end after re-building, L.T. & S.R.

"local" and that on the south the up "through" line. Two new bridges, each having three spans and carrying one set of rails, have been erected, one on each side of the railway. These carry the new roads over the Woolwich branch of the Great Eastern R. and also over Manor Road, West Ham.

Just before reaching Plaistow, the next station, the line passes under the bridge supporting the London County Council's northern outfall sewer, by means of which the drainage of the Metropolis on the north side of the Thames is con-

which the double line passed, and in addition there was a 12ft. opening at each side, sufficient for a single line, used principally for shunting purposes but not for passenger trains. These two 12ft. openings have each been widened out to 26ft., and the company have now, six lines in all passing under the bridge, four of them being the main roads, and the remaining two shunting roads for use in connection with the locomotive works and goods yards on the Plaistow side of the bridge and the extensive carriage sidings on the West Ham side.

Plaistow Station (see figs. 9, 10 and 11) has been practically remodelled throughout, and now comprises three platforms, each 600ft. long. The middle one is entirely on the island principle, whilst the outer ones, besides being used throughout their length on one side, also accommodate two bay lines (one of which is used by the North London trains), and which terminate about half-way up the length of the outer platforms. The old up platform has been moved back about 11ft. south of the position it formerly occupied, thus making room for the new up through road, whilst the old down road has been entirely removed and a new platform built along the north side of the original up road, now become the new

Between Plaistow and East Ham the railway has been widened on both sides, so that one of the new lines is on each side of the old pair. When the widening was completed the new line on the north side and the old down main line became respectively the down and up "local" lines, and these have since been equipped for electrical traction. The old up main line and the new track on the south side became respectively the down and up "through" lines.

The railway for the whole length between Plaistow and East Ham is in cutting, and except at the stations no fresh land had to be acquired, as there was enough room to widen the cutting sufficiently to allow of four roads being laid on it.

Fig. 12.—Pelly Road Bridge before re-building.

Fig. 13.—Pelly Road Bridge after re-building.

Fig. 14.—Plashet Lane Bridge before re-building.

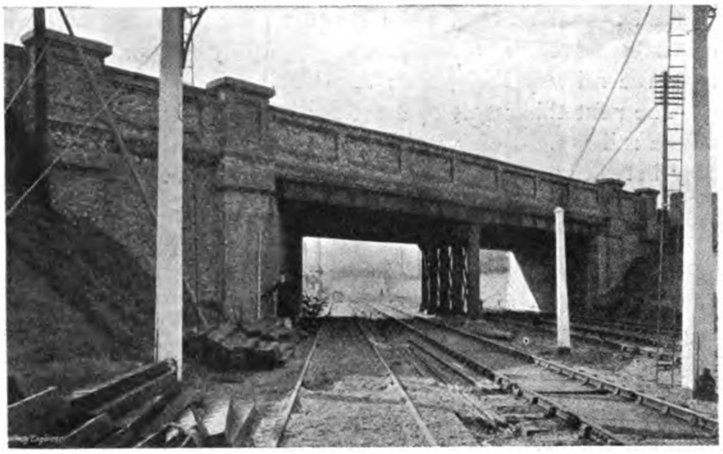


Fig. 15.—Plashet Lane Bridge after re-building.

down "through," so that in all there are four lines of railway passing through the station and two outer ones terminating at a point near the centre of the outer platforms.

All of the platforms are constructed of concrete walls, with York stone coping, and the awnings are carried by lattice girders mostly of 40ft. span supported on cast iron columns. The appearance of the stations is decidedly attractive: an artistic style of decoration has been adopted and a judicious blending of colours employed in painting the iron and woodwork. The former is of bronze green relieved with lining and the latter of light stone colour. The platform awnings are provided with central skylights throughout their length. A new signal cabin containing 128 levers has been erected at the west end of the station.

It was decided to provide a space of 10ft. 6ins. between the two sets of passengers lines in order to make room for supports to bridges, signal posts and such works being erected between the lines, without interference with the proper gauge.

Six public road overline bridges had to be reconstructed. Examples of these are shown in figs. 12 to 15. These were all 25ft. span over the railway and about 25ft. between the parapets for the roadway. Five of them were constructed of cast iron girders, with brick jack arches carried on brick abutments. The sixth had a brick arch over the line.

The following principal alterations had to be made in constructing the new bridges :—

The span over the line increased from 25ft. to 52ft.

The width of the street between the parapets increased

from 25ft. to 40ft. and in some cases 50ft. and the depth of construction between the underside of the girder and the top of the roadway limited to 2ft. 9ins. to avoid as little increase as possible on the gradient of the public street approaches on each side.

As the new bridges had to be constructed with a superstructure no greater in depth than the old ones, it was therefore impossible to cross the four lines with one span. A support in the shape of a strong steel braced trestle was erected in the centre to form two openings with a clear span on the square of about 25ft. each. The method adopted in carrying out the work of widening and lengthening these bridges was generally as follows :—A trench was excavated behind the old abutments in which the new ones were built. Half of the public road was closed and the other half carried on timbers over the trench, half of the old girders and arches over the railway being then removed.

The next thing was to erect the steel trestle in the centre of the railway. Before this could be done, however, the 6ft. way between the up and down lines had to be increased to 10ft. 6ins., but as the lines could not be slewed outwards until the old abutments were removed, it became necessary to erect a temporary bridge clear of the old one which would allow the existing lines to be slewed one north and one south. The company had in stock some old wrought iron girders sufficiently long to span the whole of the widening. Two of these were placed on the new abutments either at their east or west ends, as was most convenient, and a temporary roadway about 12ft. wide of timber was carried on them. The road traffic was diverted off the old bridge on to the temporary bridge and the whole of the abutments and girderwork of the old bridge were then removed.

Fig. 16.—East Ham Station after re-building ; L.T. & S.R.

In the meantime the cutting on each side of the bridge had been widened, and as soon as the old abutments were removed the lines were slewed out until there was a space of 10ft. 6ins., as already stated, between them, the foundations for the trestles being then put in and the trestles afterwards erected on them. By this means the trestles were erected for their full length up to the level of the girders.

Half of the superstructure, which consisted of steel girders

Fig. 17.—Signal Bridge at East end of East Ham Station ; L.T. & S.R.

and brick jack arches, was then put in place and the new roadway formed over it.

The public street traffic was again diverted for the last time on to the half of the new road and the temporary bridge removed. This left the other half of the abutment and trestle clear for the superstructure to be finished, when the whole width of the road was finally opened for traffic.

The station at Upton Park has been remodelled in the same style as that at Plaistow. The two original lines were displaced here to make room for a new island platform.

At East Ham, the present terminus for traffic on the widened lines, the station (see figs. 16 and 17) has been almost

vice of trains *via* Kentish Town between Moorgate Street and East Ham, which are accommodated in the bay road referred to at the north of the other lines.

The new local lines are actually extended to a point known as Little Ilford sidings, about ½ mile beyond the station; they will eventually be continued on to Barking, the next station on the Tilbury and Southend main line.

At East Ham Station a covered foot-bridge connects all the platforms. This is situated at the west end of the Midland bay platform. A capacious booking-

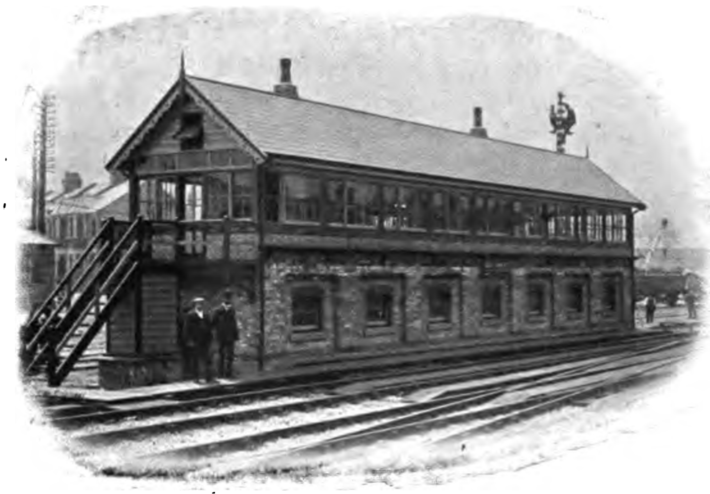


Fig. 18.—No. 2 Signal Cabin at East Ham ; L.T. & S.R.

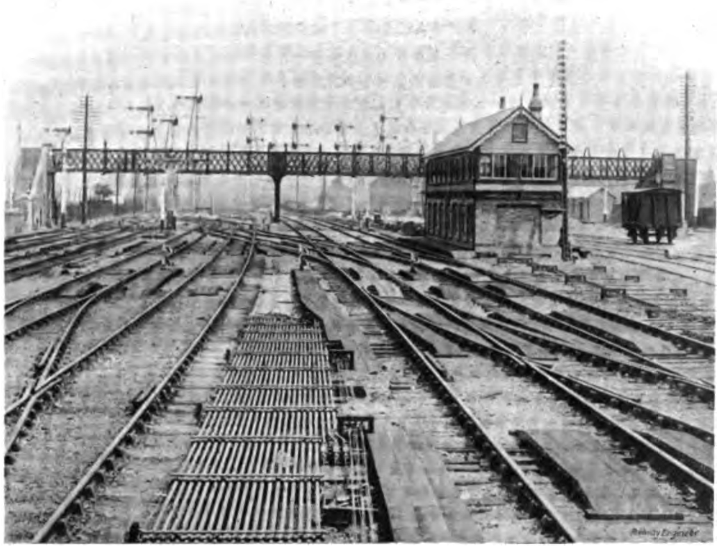


Fig. 19.—General arrangement of Connections, East Ham, No. 2 Signal Cabin.

Fig. 20.—East Ham Platform Starting Signals ; L.T. & S.R.

entirely remodelled and rebuilt. The company purchased a large area of land situated to the south of the railway at this point, and thereon placed the new lines and platforms and also brought into use a new goods yard of considerable proportions.

The new station is served by 5 sets of rails, viz. : the two "through" lines between Fenchurch Street Station, Tilbury and Southend, the two additional "local" lines used almost entirely by the District Company's trains, and the bay road for the branch line to Woodgrange Park. At the last is the junction of the Tottenham and Forest Gate Railway, owned jointly by the Midland, and the L., Tilbury and S. R. Co., forming a continuation of the Tottenham and Hampstead R. Over these lines the Midland R. Co. run their ser-

hall is provided, and this has been rendered attractive in appearance by the free use of white and brown glazed bricks for the walls, and varnished pitch pine for the woodwork of the roof.

The signalling arrangements at East Ham are entirely new as a consequence of the widening scheme. There are two cabins, one at the east end and the other at the west end of the station. The former is of large proportions, measuring 72ft. by 13ft. The floor is 8ft. above the rails. It contains 136 levers. The cabin at the west end is 40ft. by 13ft.; the floor is also 8ft. above the rails. Its frame has 65 levers. At this end of the station there are two double line junctions, cross over roads and siding connections, making a total of 15 pairs of points and 35 signals. From No. 2 cabin at the

east end are controlled three double line junctions, crossover roads and connections, making a total of 39 pairs of points and 75 signals. Figs. 18 to 20 illustrate this cabin and also the signalling installations connected with it. In addition to the facing point locks, bars are provided, and these work simultaneously with all the trailing points having connection with the running lines, these bars being introduced to prevent the signalman in the cabin from operating the points until the trains are clear. This system is being adopted on all new works and has been found effective in obviating derailments. The bridge signals, and bracket signals with more than two posts, are of the iron lattice work type; all main signals are provided with adjusting apparatus in the cabin so that the necessary adjustments may be carried out by the signalman as required, and all shunting signals are detected with the points to which they refer. Electrical locking between signals and block telegraph working known as "Sykes lock and block" system has been installed on the old and new lines for the distance between Campbell Road and the signal cabin on the country side of East Ham. This work has been carried out by the W. R. Sykes Interlocking Signal Company.

It may be added that the traffic dealt with by the signalmen in No. 2 cabin necessitates upwards of 5,000 lever movements and 4,500 movements in connection with Sykes block working during 24 hours. There are upwards of 20 miles of signal wire and 7½ miles of point rod connections in use at East Ham Station, controlled from two signal-boxes. The new arrangements were installed by the Railway Signal Company, of Fazakerley, Liverpool, and the whole of the plant has so far given the greatest satisfaction in working.

It must be borne in mind that the work entailed by the widening has meant a good deal more than merely running two lines of new way alongside the old ones. The existing one span overline bridges instead of being only lengthened were removed and longer ones with two spans erected in their place, carrying much wider roads over them, for which approaches on each side had to be found. The stations were not added to, but, being small and inadequate for the traffic, they were entirely rebuilt on a much larger scale. The signal work has been more than doubled, for the reason that in addition to the two new lines to be equipped, there are also the numerous junctions and crossover roads between the through and local lines at each station. To give practical proof of what this means, it may be stated that there are now in Plaistow Station cabin more levers than existed in all the cabins between Bromley and Barking before the widening was commenced.

The engineer employed the men in his own department for carrying out all the earth work in the widening of the cuttings and embankments, and the ballasting and laying of the permanent way.

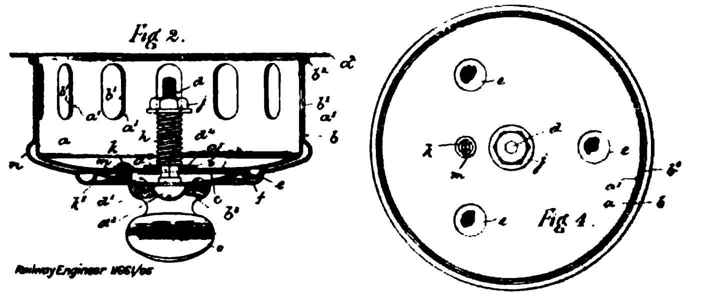
The chief contractors for the new stations and bridges were Messrs. Mowlem and Co., Ltd., of Westminster, by whom the work was carried out with their usual thoroughness and expedition. The completion of the scheme may be said to have had the effect of metamorphosing the section of the railway comprised in it, so that in place of an inconveniently arranged and much overcrowded length in the most thickly populated district of their line, the L., Tilbury and S. R. Co. have secured a well-organised and well-equipped railway, by means of which they will be able to deal with even a larger volume of traffic than heretofore without difficulty.

In conclusion, the writer has to express his thanks to Mr. Jas. R. Robertson, M.Inst.C.E., engineer of the London, Tilbury and Southend Railway, for his kindness in providing facilities to inspect the new works, and to those members of his staff who have in various ways rendered assistance towards the compilation of this article. In addition thanks are due to Mr. Robertson for providing the photographs from which the accompanying illustrations have been prepared. There can be no doubt that the many difficulties associated with the work of widening the railway between Bow and East Ham have been overcome in the most creditable manner, and both the company and their engineer are to be congratulated thereupon.

Recent Patents relating to Railways.

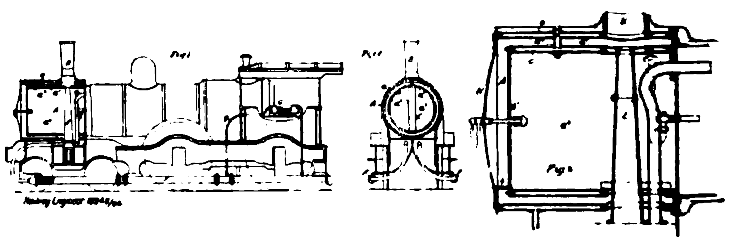
THESE abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d.* each.

Ventilators. *11,661, 3rd June, 1905. J. Levick, Metal Spinning Works, Alma Street, Aston, Birmingham.*
This ventilator, which is applicable to the roofs of railway carriages, consists of two perforated metal shells arranged one over the other with the inner one consituting the fixed body part of the appliance whilst the other is rotatable upon the body for the purpose of opening, closing, and regulating or adjusting the size of the air passages formed by the perforations. The parts



are pivotally connected to one another, whilst one of them is provided with an annular series of separated contacts or spheroidal studs, engaging with a corresponding circular groove, or channel in the other part, whereby the walls of the socketing shells are held out of frictional contact with one another, and a free and smooth action obtained without the use of ball bearings. (*Accepted, 20th July, 1905.*)

Locomotives. *15,948. 18th July, 1904. F. H. Trevithick, Maison Swares, Cairo, Egypt.*
The feed water of a locomotive or other combined engine and boiler is heated by causing it to pass through two communicating

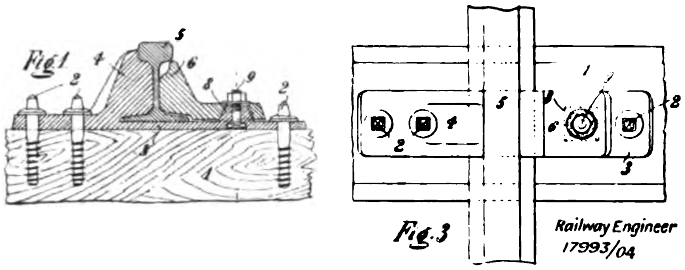


concentric annular chambers a, a^1, arranged within the smoke box, and heated by the waste gases from the furnace, which are caused to pass from the central space a^2 in the smoke box through an annular space between the concentric chambers before escaping to the smoke stack. Two tubulus vessels **F**, which communicate with the exhaust ports of the cylinders, serve as preliminary heaters for the feed water. A spark arrester is also

provided, consisting of a perforated plate or wire netting h^1 covering the end of the central chamber a^2, through which the waste gases pass. (*Accepted 13th July, 1905.*)

Rail Chair. *17,993. 19th August, 1904. J. Niemeyer, 128, Allee, Barmen, Germany.*

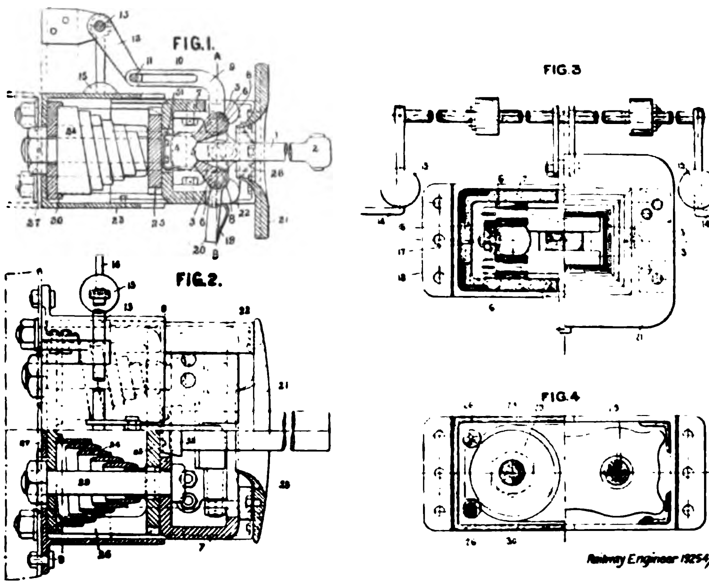
The chair consists of a bed plate 3, surmounted on one side by a solid block or fixed jaw 4, which on the side facing the rail is so shaped that its outlines fit exactly to the corresponding outline of



the rail and its height is exactly the same as that of the latter. At a suitable distance from the block 4 the bed plate 3 is provided with a pyramidal projection 8 with a hole passing centrally through it for a screw bolt 9. A removable jaw 6 serves to fix the rail 5 on the chair. (*Accepted 6th July, 1905.*)

Buffing and Draw Gear. *19,254. 6th September, 1904. A. R. Hill, District Loco Superintendent, Khurda Road, Bengal Nagpore Railway, and E. Stephens, 15, Garden Reach, Calcutta, India.*

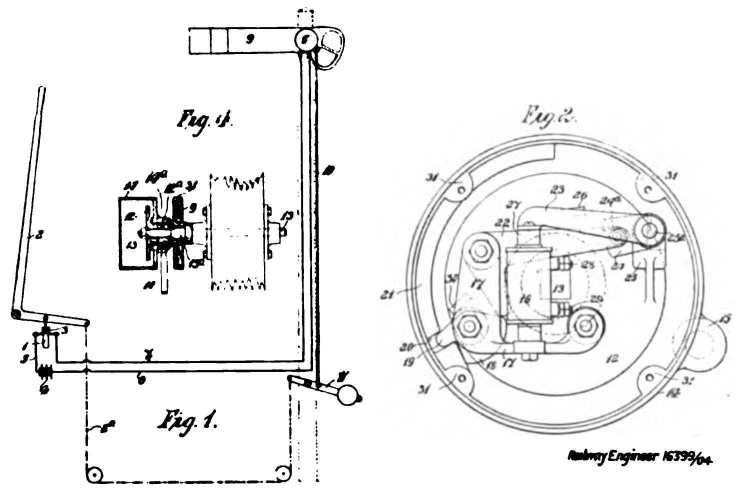
The coupling is performed automatically by means of the draw-bar 1, which is formed with similar notches or lugs 2 at both ends and inserted between the pawls 3, which close behind the head 4 and retain the draw-bar. A bent lever 9 is connected with the upper pawl and with a transverse operating shaft provided with hand cranks, and weights for keeping the upper pawl in the engaging position, whilst a spring 19 bearing against a lever 20 keeps the lower pawl in the engaging position. Arms 16, 18 on the pivots of the pawls are connected by a pin and slot connection



and arranged to transmit to the lower pawl any motion imparted to the upper pawl. To avoid shock or jar to a vehicle the buffer face plate 21 is fixed to a frame 22 which is capable of movement in the casing 23. Within the casing 23 are provided springs 24 arranged in cradles 25. Any push on the buffer face plate 21 is transmitted by the frame 22 and the buffer box 7 to the springs 24, causing them to compress and the rods 26 of the cradles to pass through the headstock 27. Springs 28 are secured to the frame 22 and bear upon the buffer box 7, to maintain by their pressure the close contact of the buffer faces of two coupled vehicles, and thus avoid shock or jar to the vehicles when in motion. To provide for hauling draw-bolts 29 are fixed to the buffer box 7, which pass through the springs 24. These draw-bolts are arranged to pass freely through holes in the headstock 27, and are provided with washers 30, which bear against the headstock under compression, but when the vehicle is hauled the draw-bar causes the buffer box 7 to slide in the casing 23, and the draw-bolts 29, acting through their washers 30, to compress the springs 24. (*Accepted 6th July, 1905.*)

Signalling Apparatus. *16,399. 25th July, 1904. J. P. O'Donnell, Palace Chambers, Bridge Street, Westminster.*

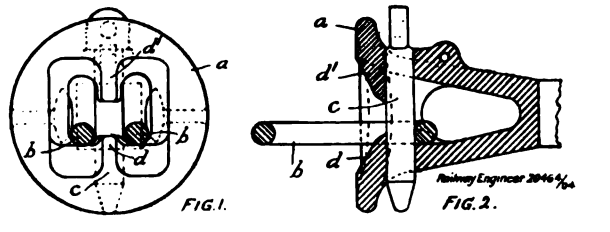
This invention relates to electric controlling apparatus for controlling the operation of a signal from two or more places on the railway. A box or casing 14 is mounted directly on the spindle or centre 13 on which the signal arm 9 works, and has a lug 15 to which the usual operating rod connection 10 is attached. Within the box 14 is a disc 12 which is rigidly fixed to the spindle 13, the box being rotatively mounted on the disc, and an electric clutch device is mounted on the disc. The electric clutch mechanism comprises an electro-magnet 16 mounted on a bracket 17 on the disc 12, and a pawl 19 capable of engaging in a recess



20 in the casing 14. A bell crank 22, to which the pivoted armature 23 of the electro-magnet is operatively connected, holds the pawl 19 in engagement with the recess when the magnet is energised, thus locking the disc 12 and signal arm to the box or casing, so that when the box is revolved by the working of the connection 10 the signal will be operated. When the magnet is de-energised the signal arm is free to move automatically into the "danger" position and cannot be operated by the usual connections until the circuit through the magnet is completed (*Accepted 13th July, 1905.*)

Buffer-Coupling.—*20,464. 22nd September, 1904. Edgar Allen and Co., Ltd., Imperial Steel Works, Sheffield* (a communication from P. A. Hyde, Chief Locomotive Superintendent, Central South African Railways, Pretoria, Transvaal.)

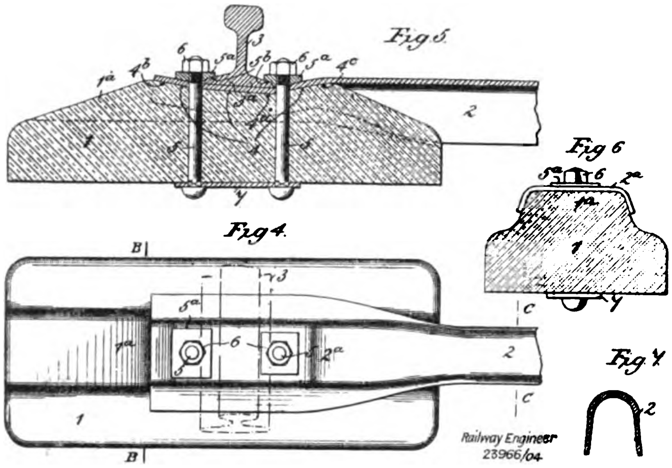
The interior surface of the bell-mouthed buffer head is provided with lugs d, d^1, adapted to afford support to the front side



of the coupling pin c, thereby materially reducing the bending moment at the centre of the pin. In order that the lateral play of the link may not be interfered with the lugs are reduced in width outwardly. (*Accepted 20th July, 1905.*)

Rail Supports and Ties. *23,966. 5th November, 1904. H. Livesey, 14, South Place, Finsbury Pavement, London.*

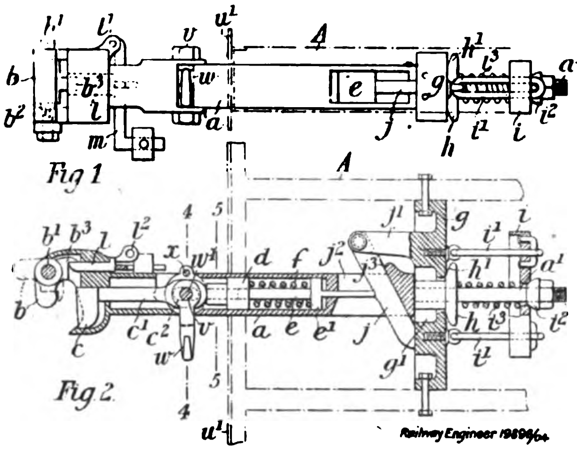
The rails are supported and held in position by blocks of concrete, artificial stone, slag, timber or other suitable material moulded or formed to shape and connected together in pairs, at a suitable distance apart to suit the railway gauge, by a rigid metal bar or transverse connecting member the end portions of which are shaped to engage the upper portions of the pair of blocks so as to hold the blocks together in a transverse and longitudinal



direction and also to form seats for the two rails to be supported. Each rail is firmly held in place between the corresponding end portion of the transverse connecting bar and suitable holding down or fastening devices that are adapted to firmly engage the foot of the rail and are connected to the transverse bar and block. The connecting bar is of channel section, and has its ends bedded in recesses in the upper surfaces of the blocks. (*Accepted 27th July, 1905.*)

Couplings, Automatic. *19,896. 15th September, 1904. P. Donaldson, 82, Victoria Street, Westminster (a communication from E. C. Gayer, 11, Hasting Street, Calcutta, India).*

Each coupler comprises a pivoted front jaw *b* and a loose rear jaw *c*, fitted upon a shank c^1 located within the hollow draw-bar *a*, in which it can move longitudinally. The pivoted jaw has a tendency to swing open and keep open, and is secured in the coupling position by a catch *l*, provided with a counterweight *m*. The shank c^1 of the loose jaw bears against a thimble *d* loosely



mounted on a rod *e* on which a spring *f* is coiled. A fixed cross-head *g* has a central hole g^1 through which the end of the draw-bar extends, the portion which engages with the hole having a thimble *h* provided with a spherical bearing face h^1, which makes contact with the edge or lip of the opening. A second cross-head *i* is connected by links i^1 with the cross-head *g* and a spring i^3 is interposed between the thimble *h* and cross-head *i*. An arm *j* pivoted to the cross-head *g* passes through a slot j^2 in the draw-bar in front of the inner end of the rod *e*. When the couplers are engaged the front jaw of each coupler is gripped between the jaws of the opposing coupler, and when the coupling is in tension the spring i^3 is compressed, the lever *j* coming against the inner end of the rod *e* and applying the loose jaw with the necessary force against the front jaw of the opposing coupler. The front part of the draw-bar may be hinged and provided with an ordinary coupling-hook. (*Accepted 13th July, 1905.*)

Buffer and End Steps.—*21,912. 11th October, 1904. A. G. Spencer, 77, Cannon Street, London.*

According to this invention the buffer cases and end steps of carriages are provided with non-slipping treads 1, of india-rubber or other suitable material, secured by holding down strips 2. Or the tread may be vulcanized to the upper side of a perforated

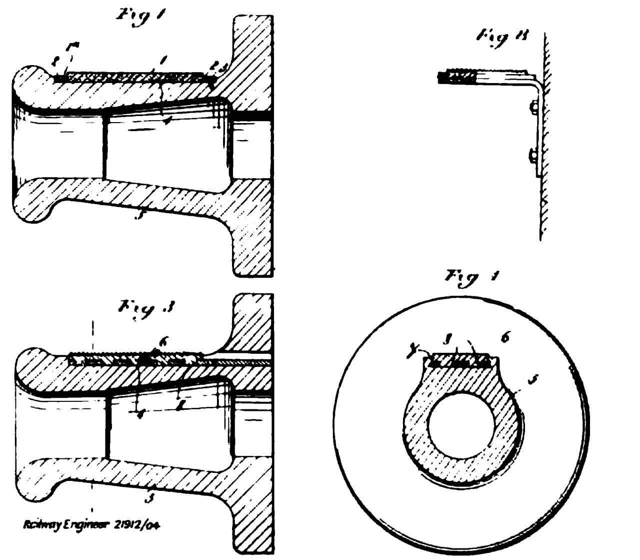


plate-like holder 7 formed with bevelled sides and attached to the top of the buffer case by sliding it endwise into a dove-tail groove formed in the latter. (*Accepted 27th July, 1905.*)

SPECIFICATIONS PUBLISHED.

A.D. 1904.

14876. Life saving guards for tramway cars and the like. Ellis.
15778. Contact stud and switch for use with surface contact systems of electric traction. Griffiths and Bedell.
15873. Railway and tramway vehicles. Gibbs.
15948. Locomotives, semi-portable engines and the like. Hardingham (Trevithick).
16399. Railway signalling apparatus. O'Donnell.
17993. Railway chairs. Niemeyer.
18449. Apparatus for boring railway sleepers. Collet.
18592. Electric railways. Carolan (General Elec. Co.).
18868. Couplings for railway carriages, wagons and like vehicles. Bray, Bray and Bray.
19124. Fan apparatus adapted for circulating and cooling the air in the compartments of railway, tramway and other vehicles, and the compartments of ships. Taylor.
19238. Lock nuts. Glossop.
19254. Combined buffing and draw gear for railway and other vehicles Hill and Stephens.
19540. Combined rail and road electric tramway system and vehicle therefor. Dixon and Dixon.
19896. Automatic couplings for railway and other vehicles. Donaldson (Gayer).
19981. Destination and stopping place indicators particularly adapted for use on railroads or the like. Brown.
20073. Points for tramways and light railways. Bland and Radford.
20343. Buffer springs for railway vehicles. Timmis.
20464. Coupling buffers for railway and the like vehicles. Edgar Allen and Co., Ltd. (Hyde).
20607. Supporting the rails of railways, tramways, and the like. North and Metcalfe.
20708. Means for changing the gauge of railway and tramway wheels. Hinton.
21912. Buffers and end steps for railway vehicles. Spencer.
23966. Means for supporting and holding railway rails. Livesey.
27112. Locking mechanism for doors of railway carriages and such like vehicles. Thompson.
29131. Trains of wagons. Adam (Koppel).
357. Automatic coupling buffers for (Robinson and Letchford) railway trucks and other vehicles. Edgar Allen and Co., Ltd.
1827. Method of and means for controlling railway carriage doors. Hildersley.

2119. Signal indicating devices for locomotives. Von Zeppelin.
2780. Tramway and railway points and switches. Leighton.
5863. Electric train signals. Sullivan and Renshaw.
5928. Railway rail joints. Robins, Lawrence, Dean and Cady.
7203. System of lining railway and other tubular tunnels. Bennett and Twining.
10100. Overhead current collectors for electric railways and tramways. Platte.
10156. Nut locks. Fletcher.
11661. Ventilators for railway and other carriages and for analogous uses. Levick.

Vestibule Trains; Great Indian Peninsula Railway.

By the courtesy of Mr. A. M. Bell, carriage and wagon superintendent of the Great Indian Peninsula R., we are able to illustrate what is generally acknowledged to be the handsomest public train in India and which has recently been constructed to Mr. Bell's designs at the company's works at Bombay. It is apparent from the drawings that the train is "quite up to date" in every respect and affords very similar accommodation to that found in a first-class club.

The immediate object for which the train has been built is to provide special facilities for attending the Poona races, though in the tourist season it is turned into an "Hotel" train by replacing two of the day cars with sleeping cars. The train is also used for the week-end traffic from Bombay to Lanovla a favourite resort up the Ghauts and which has developed to a considerable extent of late years.

The race special leaves Bombay at noon and runs to Poona in three hours, which is very good time seeing that it includes three stops occupying 9 minutes and two slacks to 5 miles an hour, besides the ascent of the Ghauts—1 in 40 for 17½ miles. This reduction in the time of the journey enables men to transact their business in Bombay, to change their attire, and lunch while on the way to the "Queen of the Deccan," to participate in the afternoon's sport, and to return to Bombay in the evening, dining *en route* in the special. The train is fitted with every convenience, both for ladies and gentlemen, including a pianola in the drawing-room, shower and ordinary baths, dressing-rooms, post office, etc.

Fig. 1 illustrates the "make up" of the train as it leaves Bombay.

Next to the engine (fig. 2) is a brake and lavatory composite car, 62ft. long by 10ft. wide, over the body. One end is divided into compartments for the guard with the brake fittings, two for baggage with four shelves in each, two for native servants with latrine, and one containing the guard's w.c. The other end of the car is partitioned off into a well-appointed bathroom and four private dressing-rooms, with lavatory in each; the floors are tiled and the partitions covered with "Emdica" enamelled zinc.

The maximum width allowed over all is 10ft., and this has been utilised to the full extent by abolishing all outside projections such as handles, etc. The doors open inwards, and in order not to block the opening they are only 2½ins. thick over all, which thinness has been obtained by using a compound steel and wood frame only 2ins. thick. The sliding doors of the baggage compartments close quite flush, with nothing whatever projecting outside the body.

The second and third vehicles of the train are two first-class cars, 62ft. long., and which are identical in design, except that in one of them there is a compartment for light luggage in place of one of the private compartments. Fig. 3 is a plan of these cars, which are upholstered with maroon coloured buffalo hide. The side panels are fitted with large photographs by Messrs. Clifton, and the roof panels with coloured Lincrusta.

The fourth vehicle is 62ft. long. It is a "Parlour" car (fig. 4), which is divided into a smoking-room with buffet, an open saloon, and a saloon for ladies. Tables are provided to afford additional accommodation for dining, so that all the passengers can be comfortably served at two sittings.

The "Restaurant" car is 62ft. long, and is mounted on six-wheeled bogies. It seats 40 passengers at one end and the other partitioned off into the kitchen and pantry and contains gas cookers, serving table, and all other requisites. The kitchen floor is tiled; it is provided with a high pressure water service and an exhausting fan is fitted in the roof to ensure all cooking odours being taken outside the train.

The last vehicle is a four-wheeled tender for the restaurant car for the use of the staff. It also provides further accommodation for baggage and has a compartment for the guard.

Fig. 6 gives a good idea of the external appearance of these fine vehicles, which reflect the greatest credit on Mr. A. M. Bell, who is a young man who obtained his present appointment quite recently and who was formerly with the Great Eastern R. at Stratford. He has introduced a very radical departure in Indian carriage practice and has dispensed with the unsightly outside sunshades, and has thereby been able to make his carriages of the full width, as above stated. The roofs are of the clerestory pattern, and to keep the cars as cool as possible they are lined with non-conducting material. The sides are vertical, and by adopting this method of construction lighter pillars and much less material has been used than would have been necessary had sides been of the "turn under" style with provision in the pillars for the runs for droplights, venetian sun blinds and gauze fly screens. The pillars in these cars are only 3½ins. thick.

The vestibules are of a novel type and are automatically closed by springs in tension by the operation of coupling the vehicles in a similar manner to that in use with Pullman vestibules, but upon a different principle owing to these cars having ordinary couplings and side buffers.

All the cars are fitted with electric light and are provided with powerful fans to ensure efficient ventilation and movement of the air. We hope to be able to publish further details of these interesting cars in an early issue.

A special race train is also run for second-class passengers and leaves Bombay half-an-hour before the first-class special above described. It consists of six bogie cars (of similar design to those illustrated), connected so that refreshments can be served from the buffets and from a restaurant car. The seats are arranged longitudinally and are covered with "Macoid" cloth. The decorations are in light colours and the finish generally is high-class.

Apart from the race specials, the service between Bombay and Poona has been further improved by a new train consisting of seven bogie cars, and which runs every afternoon made up as follows :—

First, a composite with guard's compartment, an open third-class having a bar for Indian refreshments, and a private compartment for native women.

Second, an open third-class car fitted with polished wood "turn over" seats.

Third, a second-class with the seats covered with imitation leather and the reversible backs with dark maroon coloured

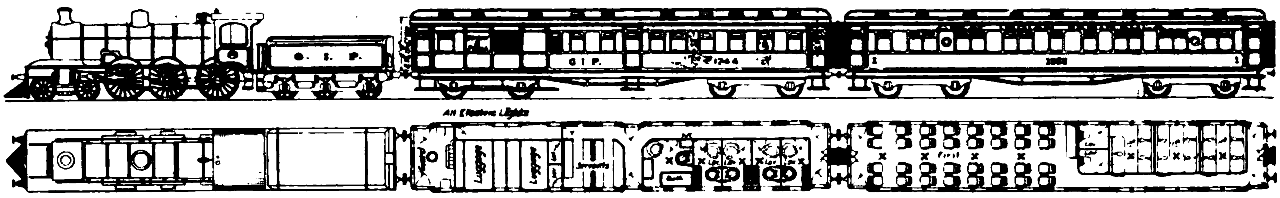


Fig. 1.—Bombay-Poona 1st Class Race Express;

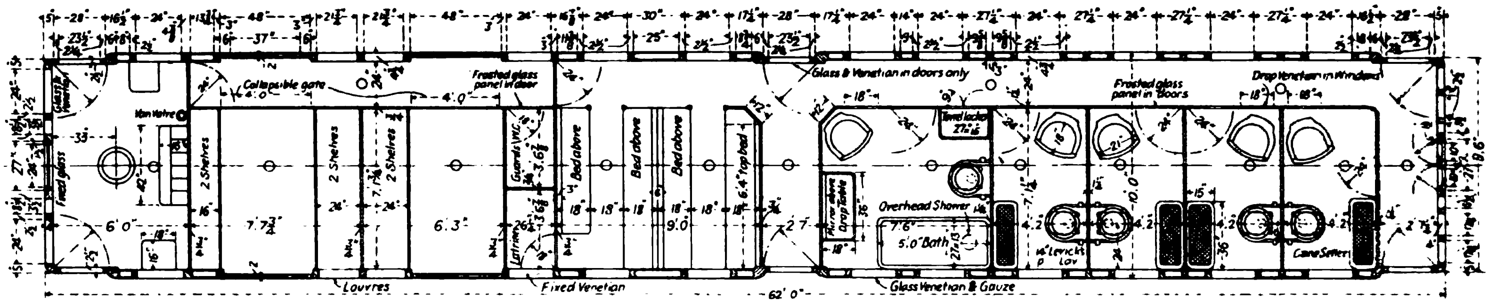


Fig. 2.—Plan of Brake and Lavatory Composite Car ; G.I.P.R

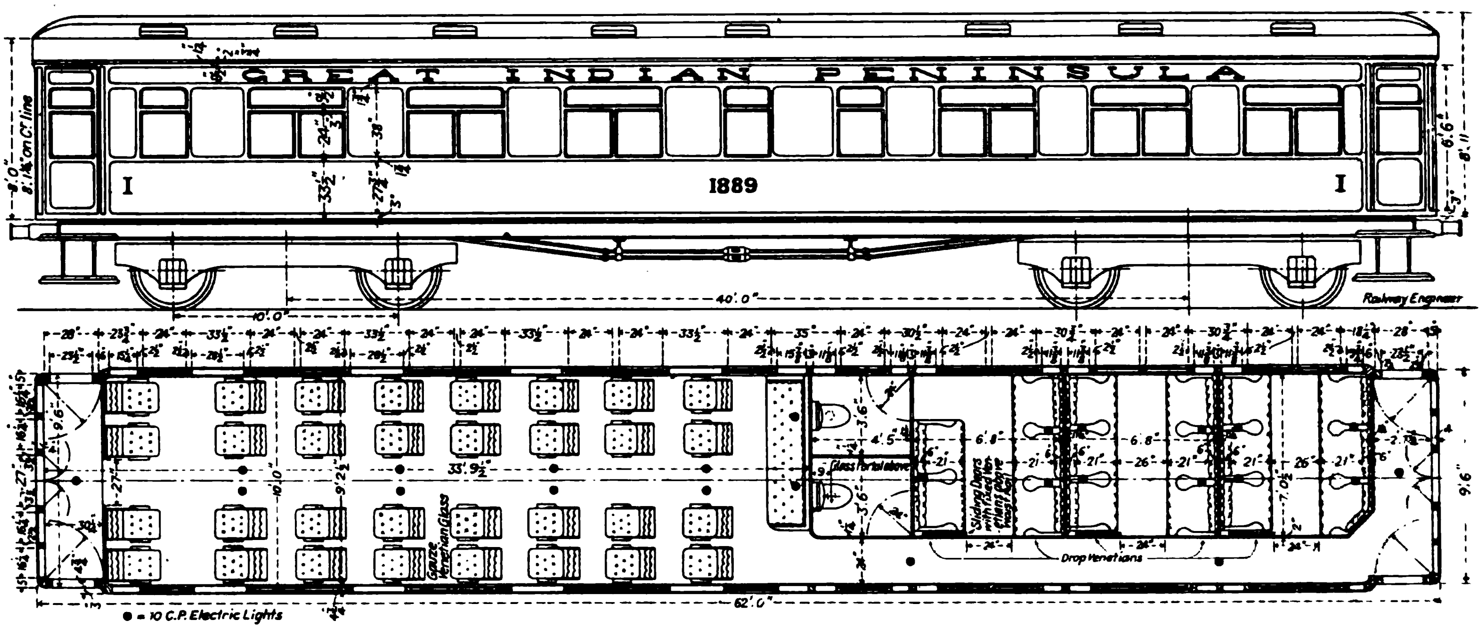


Fig. 3.—Elevation and Plan of First Class Carriage ; G.I.P.R.

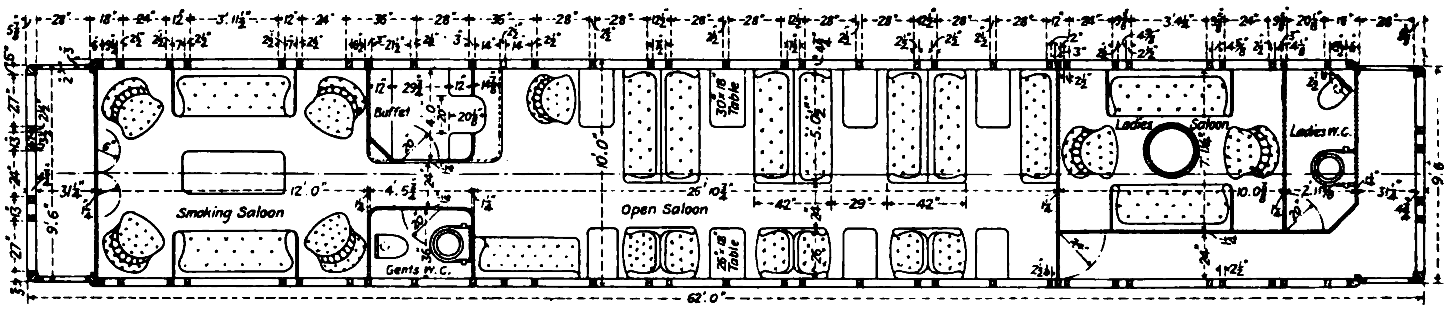


Fig. 4.—Plan of Parlour Car ; G.I.P.R.

cloth. Part of this car is reserved for ladies, and there is also a compartment for light luggage.

Fourth, a "Parlour" first-class car, furnished in one portion with easy seats and extending tables and in another with reclining chairs. There is a private boudoir for ladies and a small buffet for tea and light refreshments. An electrically-worked punkar is fitted.

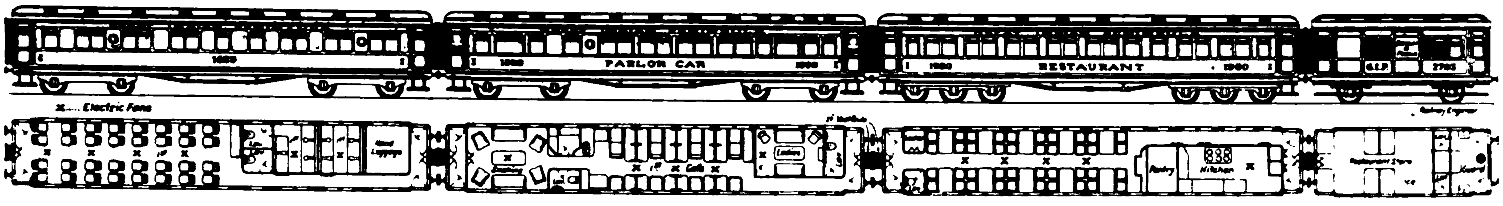
Fifth, a first and second-class composite car, similar, but finished somewhat differently.

Sixth, a restaurant car similar to that run with the race specials. The kitchen floor is covered with tiles and the sides up to the waist with "Emdica," so that it may be kept quite clean without trouble.

The last car is a composite mail third-class and baggage car.

It will be seen from the above brief descriptions that these trains will compare favourably with the public trains of any country.

In a future issue we shall publish details of the sliding and composite doors referred to above.



Great Indian Peninsula Railway.

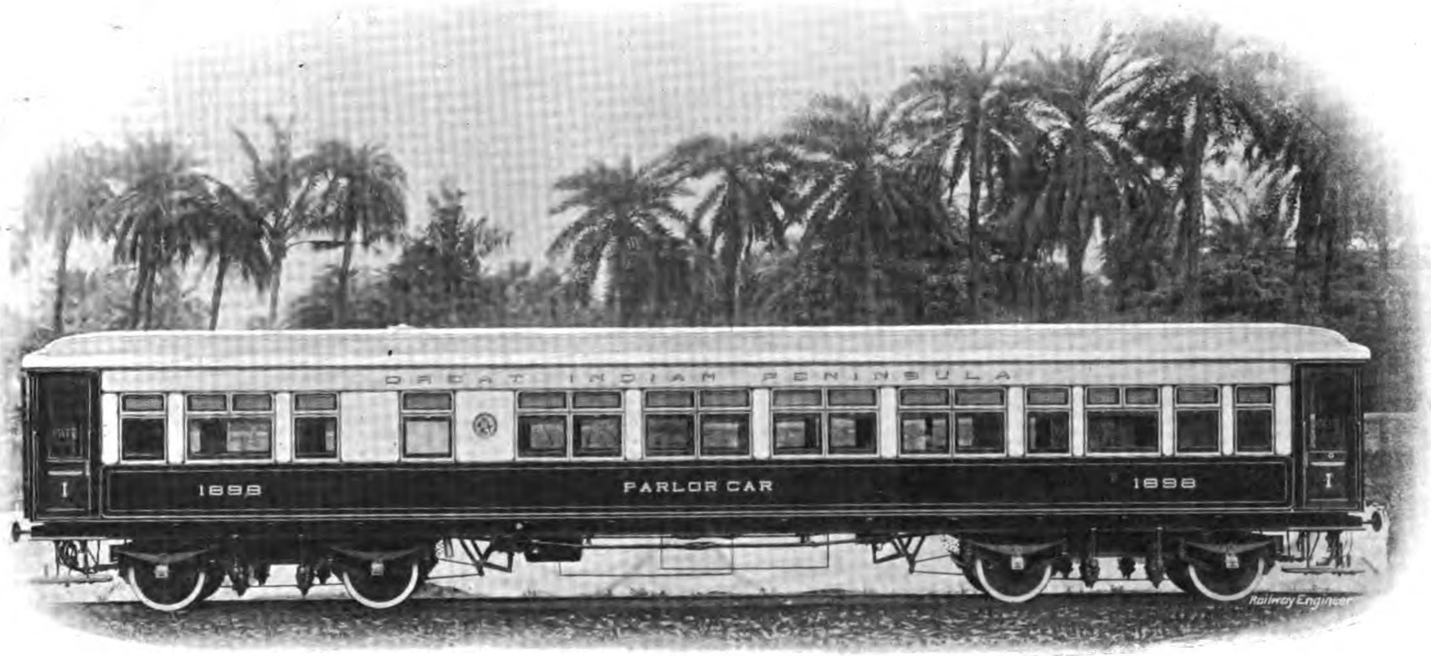


Fig. 5 —Elevation of Parlour Car. G.I.P.R.

Ferro-Concrete, and some of its most Characteristic Applications in Belgium.*

By M. ED. NOAILLON, of Chênée, near Liége.

(Continued from Page 269.)

In this manner, however, the difficulty is only set back a step, for the bar being in tension right up to the ends must lose it rapidly in a very limited space, whence arises a considerable tendency to slipping, which is met either by opening out the end into a swallowtail, or, if this is insufficient, by bending the bar upon itself and placing a cross pin in the bend. The simple oblique bar is not used for a beam with free supports.

The author has pointed out that one of the characteristics of concrete is to lend itself easily to continuity of structure; but it is clear that this may have the effect of displacing, towards the bottom, the diagram of the bending moments in such a way that near the supports certain reversed moments may be of higher value than the moment at the centre of the span. From this cause tensile stresses are produced in the top member and compression stresses in the bottom member. In order to overcome the first set it is necessary to provide new re-inforcement if it does not exist in the upper member, or raise the lower re-inforcement towards the top of the beam, which has also the advantage of neutralising the tendency to sliding, as has already been pointed out.

To overcome the second series the concrete of the lower part of the web is often insufficient, and then the lower re-inforcement is used at this point in compression. Another method which is coming into use consists of banding the concrete of the web, which, as will be pointed out hereafter, considerably increases the resistance to crushing.

When the reversal of the moments is due to the continuity of the beam and the floor platform, the use of re-inforcement in the upper part is not always necessary; in fact, the platform may then play the part of the member in tension, owing to the "distributing" bars which it contains and to the resistance to tractive efforts of the ferro-concrete itself, which the author will discuss later.

When the beams have no continuous platform at their upper part they ought to be provided with compressive re-inforcement or be banded.

Fig. 3 is a longitudinal section of a portion of a beam on the Hennebique system. It will be observed that half the bars composing the lower re-inforcement rise to the top at the supports, resisting at the same time the tendency to slide and also the moment of shearing at the junction.

The other half keep their position right to the end, where they serve to resist the compression and to support the stirrups.

Fig. 4 represents a portion of a beam built upon the system of Perraud and Dumas. The attachments are formed of a trellis of flat strips bent obliquely between the lower re-inforcement and a bar at the top, so that the body of the beam forms one mass of great rigidity which is of value in the erection. The lower ironwork is re-inforced in its central part by a bar in order to obtain as nearly as possible a section of canal resistance. This method has, however, the disadvantage of giving a minimum perimeter to the section of the ironwork at the supports, which are precisely the points where it should have its greatest value. At the level of the platform there are bars to resist shearing at the supports and compression bars in the centre.

* Read before the Institution of Mechanical Engineers at Liége, June, 1905.

The author of this paper desires to advocate a simple system which affords a re-inforcement of canal resistance and offers every security for resistance to sliding. Fig. 5 shows its application to a beam without fixed ends. For a span of moderate amount the re-inforcement consists of bars of three different lengths.

It will be seen that they leave the lower part of the web at determined distances and rise towards the floor structure, where they end in a hook. In these hooks, as well as in the angles formed by bending, there are placed transversely pins *a* and *b*. These pins are of great importance, for they represent the placing between the oblique parts of bars which may be considered as the diagonals of the web of a lattice girder and the concrete lying between *a* and *b* which is analogous to the compression bars.

The re-inforcement of a beam with platform is calculated according to the nature of its central transverse section where the maximum bending moment occurs.

As the sliding efforts there are zero, the normal sections remain flat after deformation and merely swing upon the neutral axis. This condition of conservation of the plane sections, combined with the equations of equilibrium of movement and of moments, suffices to determine the forces acting upon the re-inforcement.

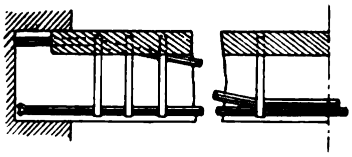


Fig. 3. Hennebique System.

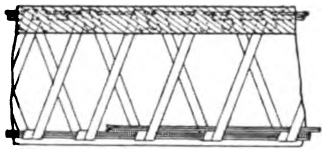


Fig. 4. Perraud and Dumas System.

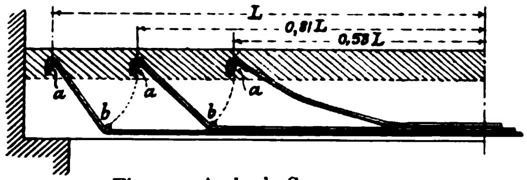


Fig. 5. Author's System.

But for this it is necessary to know the law which connects the compression of the concrete to its decrease in length. This law, however, varies within wide limits according to the composition of the concrete, and especially with the manner in which it is used in the work, the degree of fluidity, and the ramming. Moreover, the law is not linear, and is greatly affected by hysteresis, so that the deformation is a function of the duration of the compression and of the former life history of the concrete so far as stresses are concerned.

Yet when the height of the beam is great relatively to that of the floor platform the variation of the law of deformation of the concrete does not sensibly affect the forces acting upon the re-inforcement, and the section of the latter may be calculated with sufficient accuracy.

It should be noted that the elements of the floor platform which constitute the re-inforcement in compression have an efficiency which diminishes as their distance from the web increases and as the length of the beam decreases.

The Floor Platform.—When in a beam of T section the part of the concrete in tension in the web has merely an insignificant influence and may be neglected, it is desirable to enquire if it is not the same with the concrete in tension in a floor platform which has a section larger than that of the concrete under compression. Monsieur Considère has shown that ferro-concrete can extend without cracking until the re-inforcement reaches its limit of elasticity, and that the part of the resistance due to the concrete attains after the first extensions a value which remains constant until rupture occurs. It is evident that if this result is to occur the piece must be free from all cracks before the test, and to obtain this condition special precautions must be taken in its manufacture and setting. Excess of water must be avoided in gauging, ramming must be carefully done, and the piece must be kept moist during the first days of setting.

In practice these conditions are never fully realised, and therefore the rapid shrinkage of the cement produces premature tensile stresses which cause hair cracks. But these cracks never affect any great depth of the floor structure, and many contractors think that one may therefore count upon almost the whole of the concrete in tension to relieve the re-inforcement; others, on the contrary, believe that it is always dangerous to count upon this aid.

The tension of the re-inforcement of a platform will also vary with the law of deformation which it may be thought desirable to apply to compressed concrete, a law which is all the more uncertain as concrete is not homogeneous; in fact the last layer of concrete is not generally rammed so as to facilitate levelling.

It is therefore obvious that the theoretical calculation of floor structures can only have a relative value, and that the coefficients which are used in these formulæ ought to be obtained from practice.

This uncertainty in calculation is besides often hidden by the want of precision with which the re-inforcement can be fixed in the thickness of the platform.

Like the beams the platforms are very often fixed or continuous, and this condition requires re-inforcement in the upper layer, or in a simpler manner by the raising of a lower re-inforcement near the supports, fig. 2.

With respect to resistance to sliding, as the perimeter of the section of the re-inforcement is almost always less than the width of the platform, it is useless to provide stirrups.

Besides the principal re-inforcement there are placed immediately above it, and in a perpendicular direction, some "distributing" bars which are intended to interlace with several of the principal bars, and offer a better resistance to a concentrated load. In order to ensure regularity of erection the two systems of bars are sometimes bound together at some of the crossing points by means of iron wire.

When it is a question of covering a surface approximately square—a case which occurs frequently in houses—there is a great advantage in making the two systems of bars of equal strength so as to make use of all four sides of the space as supports.

The uncertainty of the conditions of stress upon the re-inforcement which is so great for the ordinary floor platforms is still more so for the square surfaces referred to above.

The re-inforcement may be fixed in lines parallel to the sides or parallel to the diagonals, the use of the latter system, which necessitates a large number of different lengths of bars, cannot be justified by any theoretical consideration; a satisfactory system consists in placing the re-inforcement parallel to the sides and grouping the bars closer together along the middle of the sides.

A simple and elegant arrangement for surfaces of small dimensions consists in the use of expended metal as the re-inforcement; perfect security is then obtained for the necessary adhesion, and a poor concrete may be employed. This method of construction can be recommended for foundation blocks.

Pieces for Resisting Compression Stresses.

Columns.—Columns are usually made of square section to facilitate centering; as a rule the re-inforcement consists of four longitudinal bars placed near the four angles, and joined at intervals by cross ties. The ties are intended to prevent the buckling of the individual bars, and also serve to retain them in position during the filling of the concrete. The cross ties consist of plates or round bars which surround the longitudinal bars. Sometimes they are twisted round each bar, or plates with holes may be threaded upon the bars.

The calculation of the re-inforcement is empirical, for the determination of the strain is first of all affected by the uncertainty regarding the law of deformation of the concrete, since it is directly proportional to the latter. Besides this the shrinkage of the cement communicates to the metal an initial compression which is often very considerable, but impossible to value beforehand. Moreover the bars also assist in resisting the tendency to buckling of the entire

column, but the buckling is proportional to the coefficient of elasticity of the column, and this value varies with the load, and is very different for the same load according as the preceding load has been greater or less than the load under consideration.

. The resistance to buckling and to crushing is much increased by the use of a concrete very rich in cement, gauged with only a small quantity of water and well rammed.

Banded Concrete.—The methods of re-inforcing concrete against compression have been revolutionised by the introduction of the banded concrete invented by M. Considère.

The very remarkable work of M. Considère has shown that metal employed under the form of bands has, from the point of view of resistance to compression, an efficiency 2·4 times greater than that used in the form of longitudinal re-inforcement. To be effective these bands ought to be circular, and should not be placed further apart than one-seventh of the diameter of the banded concrete.

By submitting the banded pieces to an initial compression, or letting them harden under water, the bands become also much more efficient than longitudinal bars in resisting buckling.

They have also the considerable advantage of being endowed with an absolutely surprising plasticity, which makes a thoroughly sound structure.

Warning is also given of excessive compression by the shelling off of the concrete covering the bands long before the structure has reached its safe limit of compression.

The simplest and most economical form of the bands is the spiral. By putting the turns of the spiral closer together it is possible to strengthen certain parts which are under the greatest stress, and give a known increase to the strength. It is also possible to re-inforce a structure already completed by winding round it an iron wire which is afterwards covered with a layer of plaster.

Banded pieces prepared in the workshop with all possible care, and made with a very rich concrete and subjected to initial compression, offer a resistance to compression comparable with that of a structure of riveted steel of the same weight, and are less expensive.

It is safe, therefore, to prophesy that banded concrete will be able in a large number of cases to replace with advantage the compression members made of rolled steel sections in a large metallic structure. The tension members would consist of bundles of round bars lightly banded and dipped in concrete. The connections would be more easily made than those of other frameworks, and could be re-inforced by a supplementary banding. Such structures would have an unlimited life with practically no expense for maintenance.

In this connection M. Considère has constructed and tested with complete success a bridge of 65·6ft. span entirely built of banded concrete.

An important application of banded concrete has come into ordinary use for piles. Such piles are stronger than those of wood, and have the enormous advantage that they do not rot.

PARTS SUBMITTED TO COMPLEX STRESSES.

The most important type of these pieces is the vault, in which the re-inforcement is specially designed to resist bending stresses caused by non-symmetrical or concentrated loads, whilst the concrete supports in compression those that are fixed and distributed.

The greatest uncertainty exists as to the most rational method of re-inforcing a concrete vault; the cauculation of the re-inforcement is only rendered possible by the use of empirical coefficients.

For vaults of wide span one observes that different builders follow opposite methods; some, like Hennebique, thinking that the essential character of ferro-concrete is the opportunity which it gives for producing monoliths and of profiting in all cases of possible bonding, form their vaults of a series of ribs in arcs connected at their upper parts by a horizontal platform; the arc has then near the supports its maximum of height and this permits a good bonding with the abutments. Other builders seem to be haunted with the fear of the effect of expansion and of shrinkage, and give to their vaults as much flexibility as possible by making them with a cylindrical lattice work. In recent years some have gone further in this direction and formed arches with three joints.

As has been seen from the preceding remarks, it is most frequently impossible to determine accurately by means of theoretical formulæ the actual cross sections of the re-inforcement.

The best guide is experience translated as well as possible into empirical rules. Those rules will be all the more reliable according as they are based upon a larger number of structures, and from this point of view it is best to prefer the systems which have been the most employed in practice.

On the subject of principles of calculation for structures in ferro-concrete it is interesting to cite the opinion of Professor Rabut :—

"I often hear it said that structures in ferro-concrete cannot be so accurately calculated as metallic structures; in my opinion the contrary is true; the formulas for metallic bridges are in their principles just as arbitrary and just as far from the expression of the real strains as those of ferro-concrete; but the latter have the advantage of containing twice as many constants, those of iron and those of concrete, which, if these constants are conveniently chosen, will allow of approaching the truth much more nearly."

The author will now briefly describe some types of constructions in ferro-concrete which present interesting features, and will restrict his choice to recent works and those to be found by preference in the neighbourhood of Liége.

(To be Continued.)

Official Reports on Recent Accidents.

At **West Hartlepool Station, N.E.R.**; *11th July. Lt.-Col. P. G. von Donop, R.E., reports that:—*

That an excursion train (engine and 11 vehicles) from Hartlepool to Whitby, standing at the up platform at West Hartlepool Station, was run into from the rear by the engine of the 12.45 p.m. train (engine and 8 vehicles) from Hartlepool to Stockton; 13 passengers complained of injuries.

The Stockton train was fitted with the Westinghouse automatic brake working on 44 out of 48 of the carriage wheels.

The traffic to and from West Hartlepool Station is controlled from two signal-boxes, one at either end of the station. The one at the west end, Clarence Road signal-box, is 221 yards west of the west end of the up platform. The next signal-box to the west, Cemetery West box, is 1,749 yards from it. The box at the east end of the station, Church Street box, is 572 yards from the Clarence Road box.

The Clarence Road signals governing the admission of up trains into the station are:—An up home, 90 yards to the west; an up intermediate home, situated 300 yards to the west; and an up distant, 1,348 yards to the west. Both the up home and the up intermediate home signals are provided with calling-on arms.

The admission of passenger trains into the station is worked under the regulations for train signalling by recording telegraph instruments.

"Whilst the indicators show train on line, the fixed signals at "the rear box must be kept at danger with the following excep-"tion—where calling-on signals are provided a train must be "brought nearly to a stand at the home signal, after which the "calling-on signal must be lowered, which will be an indication "to the driver that he can pass the home signal at danger, and "that the section in advance is occupied."

The gradient for the last 130 yards up to the point where the collision occurred rises at 1 in 249. The up line enters the station on a curve to the left, and the driver's view of the line ahead of him is interfered with. The driver of the Stockton train in this case would not have obtained a view of the rear vehicle of the Whitby train until he was within 101 yards of it. The signals were correctly worked.

This collision was due to want of care on the part of driver Lumsdon when entering the station. Lumsdon admits that it was only the home signal calling-on arm that was lowered for him to enter the station, and that that signal was only lowered after he had nearly brought his train to a stand. He was also aware of the rule that the lowering of the calling-on arm indicates to the driver that the section in advance is occupied. Lumsdon, therefore, had been duly warned to have his train well under control when entering the station. The only explanations which he can give to account for the collision are—firstly, that when he applied his brakes the wheels skidded; and secondly, that on previous occasions he had been admitted to the station by means of the calling-on arm without finding a train standing on the up platform line. As regards the skidding of the wheels it should be noted that Lumsdon could have seen the excursion train when he was 100 yards from it, and he himself admits that when he first saw it he was over 72 yards from it; at this time he was running up a slightly rising gradient, and had he had his train well under control he should have had no difficulty in stopping his train in time to avert the collision. Lumsdon's statement as to his having previously entered the station by means of the calling-on arm without finding a train on the up platform line is probably the real explanation of this accident. Although he knew that the lowering of the calling-on arm meant that he might find a train in the station he appears to have acted on the assumption that such was not the case, and there can be no doubt that he consequently allowed his train to enter the station at too high a rate of speed. He had been on duty about 7½ hours.

*

At Burnley, L. & Y. R. *On 20th April. Lt.-Col. E. Druitt, R.E., reports that:—*

The 12.50 a.m. up goods train from Colne to Phillips Park (engine, 110 loaded wagons, 3 empty wagons, a brake van, and 2 banking engines) was leaving Burnley (Bank Top) Station, when the 85th wagon from the train engine, with the 4 following wagons, left the rails at a crossing of a siding connection in the up main line.

There is not any extra danger to the men working long trains, though perhaps greater skill and care are required in the manipulation of them, but this has been forthcoming. Their records show that accidents have been neither more numerous since the introduction of long trains in 1901, nor do they happen more frequently to long trains than to short ones.

The length of goods trains will be gradually reduced when larger numbers of high capacity wagons become available, but meanwhile the old type of wagons must be continued to be used. A smaller number of wagons though conveying the same tonnage will be more compact and easier to handle.

The Company claim a great advantage in working traffic, by using one long train in lieu of two short trains on a crowded line with numerous block sections, the saving of time being very considerable.

The principal source of danger to passenger trains from goods trains is probably that in the case of a long train a wagon off the road might not be noticed by the trainmen so soon as in that of a short train, and the other road on which a passenger train might be passing may be fouled and the danger not noticed so soon; but no accident has happened from this cause owing to the introduction of long trains, which are now limited to 120 vehicles on the L. and Y. R., whether loaded or empty.

*

At **Waverley Station, Edinburgh, N.B.R.,** *27th June. Major J. W. Pringle reports that:—*

The 2.55 p.m. down train (tank engine and seven vehicles) from Leith Central ran into the buffer stops of No. 3 bay platform line at Waverley Station: 12 passengers and the guard were injured. The buffer stops were broken, and two of the coaches slightly damaged.

In front of the six carriages, which ordinarily composed the train from Leith, there was an empty covered South-Eastern and Chatham R. carriage truck fitted with Westinghouse and vacuum brake pipes only. The position of the Westinghouse brake train-pipe cocks differed on this truck from the position of similar cocks on the North British R. stock. In the latter the cock is above the pipe and in an horizontal position when the pipe is open; in the case of the foreign truck the cock is underneath the pipe, and when horizontal the pipe is closed. It is opened by pulling the cock handle into a vertical position.

It was fireman Thomson's duty to couple the engine and truck, and porter McCrae's duty to couple the truck to the coaches. The latter, however, performed both duties. He explains that at both ends of the truck, after coupling the Westinghouse hose pipe, he pulled down the cock into the vertical position, and heard the noise made by the air under pressure passing along the pipe. Fireman Thomson confirms this statement that the coupling at the leading end of the truck was correctly done.

Guard Hutton affirms that when the coupling up was complete he tested the brake connection in the manner prescribed, and finding it complete he showed driver Taylor first a white flag in token that the brake connection was complete through the train, and then a green flag to authorise him to start.

Driver Taylor was not able to start the train, and sent fireman Thomson to see if any of the brake blocks were holding the train. Thomson found the blocks tight on the wheels of the fourth vehicle, and eased them by drawing out the wire.

The train was then started, and on arriving at Waverley Station, after a run of a few minutes without an intermediate stop, Taylor applied his continuous brake in the usual manner, in order to bring the train to a stand. He found the speed of the train was not checked as he expected, and a collision resulted with the buffer stops at the end of the platform line.

Immediately after the collision, carriage-examiner Jamieson found the bake cock at the trailing end of the carriage truck in the horizontal position. The air pressure was thereby cut off from the coaches, and the failure of the continuous brake to check the train in the usual manner was fully explained.

According to the evidence of McCrae the position of the trailing brake pipe cock on the truck was correct when he tested the brake for continuity. But it is evident that the position of the cock could not have been altered whilst the train was travelling between Leith and Edinburgh, and yet the cock was found in the closed position immediately after the collision. The train must have started from Leith with the brake pipe closed behind the truck. The only solution of the problem which appears possible is that either fireman Thomson, or guard Hutton, altered the position of the cock after the latter had tested the brake, and before the train started.

Whatever the real truth may be on this question, driver Taylor, by neglecting to test the continuous brake before passing the distant signal for Waverley terminal station, in accordance with his instructions, and by failing to enter the station at such a speed as to enable him to stop his train at the proper place by the application of the hand brake only, is partly responsible for the collision. He had been on duty 10¼ hours.

There is a speed restriction on all lines in Waverley Station between the signal-boxes of 4 miles an hour. It is true that the consensus of evidence given by eye-witnesses as well as the enginemen themselves is to the effect that this speed limit was not exceeded. But judging from the damage done to the buffer stops, either that a speed of 4 miles an hour is too high in a terminal station where it should be possible to control a train by the hand brake only, or that the witnesses are not good judges of speed.

Guard Hutton admits that he was ignorant of what was the proper position of the brake cocks on the foreign carriage truck with the train pipe open, and yet he was responsible in accordance with the instructions for seeing that the cocks on the brake pipe were all open.

This accident proves the additional risk incurred by railway companies, even when the same type of continuous brake is used, by varying details of brake equipment instead of standardising them.

EDITOR'S NOTICE.—All manuscripts and communications should be distinctly written, or preferably type-written, on one side of the paper only, and addressed to the Editor, **3, Ludgate Circus Buildings, London, E.C.** The Editor cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped directed envelope.

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THE
Railway Engineer

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Contents for November.

Mr. L. R. Starkey, of Southwell, has retired from the Board of the Midland R.

Mr. R. L. Wedgwood, secretary, North Eastern R., has been appointed divisional goods manager at Newcastle, and **Mr. R. F. Dunnell**, assistant solicitor, has been appointed to succeed him as secretary, which post he will hold in conjunction with his present one.

Mr. Geo. Hope, assistant general manager, North Eastern R., has been appointed divisional superintendent at Newcastle, in succession to **Mr. T. Pickering**, who has retired; **Mr. T. Chatt**, district goods manager at Newcastle, and **Mr. J. M. Hicks**, superintendent Tyne Dock, have also retired.

Mr. B. St. G. Yerschozle, assistant engineer, Buenos Ayres and Rosario R., has been appointed resident engineer of the Egyptian State R.

Mr. T. C. Higgins, chief clerk to the mineral manager, Great Central R., has been appointed mineral manager in succession to Mr. John Watkin.

Mr. E. E. Lucy, assistant divisional locomotive superintendent and manager of the Stafford Road Locomotive Works, Great Western R., has been appointed assistant chief mechanical engineer of the New South Wales Government Railways. Mr. Lucy entered the Stafford Road works in 1879 as a pupil of the late Mr. George Armstrong. After his pupilage he was assistant draughtsman and then assistant foreman at Stafford Road, and subsequently successively district foreman at Landore, Swansea, Weymouth and Plymouth. He was appointed to the position he vacated on the 21st ult. in 1897. He is a member of the Institution of Mechanical Engineers. He sails to take up his new position in the ss. "Ormuz" on the 17th inst.

Mr. Henry Fowler, gas engineer, Midland R., has been appointed to be also assistant locomotive works manager.

Mr. F. Wood, of the New Zealand Shipping Co, and formerly of the North-Eastern R. at York, has been appointed assistant locomotive and marine superintendent of the Leopoldina R.

Mr. Roger T. Smith, of Messrs. Kennedy and Jenkins's staff, has been appointed electrical engineer to the Great Western R.

It is with great regret that we record the death of **Mr. William Dean**, late locomotive, carriage and wagon superintendent of the Great Western R., and which took place on the 24th September at Folkestone after our last issue had gone to press. The news of his death, though not unexpected, was received with most sincere and profound regret by all his old colleagues and assistants, and, in fact, by everyone who had ever had the pleasure of his acquaintance.

He was born on January 9th, 1840, and entered the Wolverhampton works of the Great Western R. as a pupil of Mr. Joseph Armstrong (who was then locomotive superintendent of the narrow gauge section) in October, 1855. In 1863 he was appointed chief assistant to Mr. Armstrong, who in 1864 was removed to Swindon as chief locomotive and carriage superintendent of the whole of the Great Western system. In June, 1868, Mr. Dean also removed to Swindon as Mr. Armstrong's principal assistant, and on the death of Mr. Armstrong, in 1877, he was appointed to succeed him, and held the position until he retired 25 years afterwards, in June, 1902. He devoted his life entirely to the Great Western R. He took a great interest in the Volunteer movement, and held the rank of honorary major. He was a J.P. for Wilts, a member of the Institution of Civil Engineers, and of the Council of the Mechanical Engineers. Unostentatious philanthropy was one of his prominent characteristics.

We also record with regret the death of **Sir William Shelford, M.Inst.C.E.**, who was connected with the construction of many important railway undertakings, notably the Hull and Barnsley R., and latterly as consulting engineer for the Crown Agents of the Colonies with the Lagos R. He died on the 3rd ult.

And also with regret the death, on the 18th ult., of **Mr. R. H. Hone**, of Messrs. F. C. Mathews and Co., solicitors to the L. Tilbury and Southend R. Mr. Hone, in company with the engineer of the company, Mr. Jas. R. Robertson, was walking along the line near Southend when he stepped the wrong side just in front of a train and was killed instantly, being shockingly mutilated. Mr. Robertson in attempting to save Mr. Hone had a narrow escape.

*

Shackle and Pin Wagon Couplings.

THE following notice has been issued from the Railway Clearing House:—The railway companies of Great Britain and Ireland hereby remind private wagon owners and others of the following

arrangement which has been made between the Association of Private Owners of Railway Rolling Stock, the Mining Association of Great Britain, and the railway companies :—Shackle and pin couplings are to be discarded as from 31st December, 1905, and replaced by three link draw-chains of the dimensions given in the standard specifications for new wagons.

*

Motor Omnibus Service at Holywell, L. & N.W.R.

ON the 11th ult. the L. and North Western R. Co. commenced running a service of motor omnibuses between Holywell Station and Holywell Town, North Wales. The town, 1¾ miles distant, is on the side of Halkyn Mountain, 550 feet above the railway station, and parts of the road are as steep as in 1 in 9. The omnibuses meet every train at the station, and make 18 journeys daily to the town and back. The experiment is proving very popular, as it is nearly 15 minutes quicker than the horse vehicles hitherto plying between the same points. The new service is expected to bring a great many visitors and pilgrims to St. Winifred's Well, which has been noted for over 1,200 years for its healing properties.

*

Regulations for Locomotives and Wagons on Lines and Sidings under the Factory Act.

THE Secretary of State for the Home Department, in pursuance of Section 81 of the Factory and Workshop Act, 1901, has appointed Mr. Chester Jones, Barrister-at-Law, of 1, Paper Buildings, Temple, E.C., to hold an enquiry with regard to the draft regulations for the use of locomotives and wagons on lines and sidings under the Factory Act, published in pursuance of Section 80 of that Act.

The enquiry, which is a public one, will be opened at the Caxton Hall, Westminster, London, on Wednesday, November 22nd, 1905, at 10 a.m.; and any person who has objected to the draft regulations, and any other person who, in the opinion of Mr. Chester Jones, is affected by them, may appear either in person or by counsel, solicitor or agent.

*

Westinghouse Single-phase Locomotives for Main Line and Suburban Railways.

THE Westinghouse Electric and Manufacturing Company have recently secured an important contract from the New York, Newhaven and Hartford Railway Co. for the supply of 25 single-phase electrical locomotives for service on the company's main line, which is being converted to electric traction.

The single-phase overhead wire system has been adopted, but the locomotives, which are being built by the Baldwin Locomotive Co., will also use direct current where they traverse the line of the New York Central, which serves the suburbs of New York.

Each locomotive will be equipped with four 400 h.p. Westinghouse single-phase motors of the straight series gearless type, and the unit switch system of multiple control will be used.

The weight of the locomotives is approximately 78 tons, and, with a 200 ton train making stops every 2·2 miles and attaining a maximum speed of 45 miles an hour the schedule speed will be 26 miles per hour. Express trains of 250 tons will be propelled at from 60 to 70 miles an hour by one locomotive, but heavier trains will be run by two or more locomotives coupled together and controlled from the forward cab.

The motors are to be spring supported and connected by flexible drive in such a manner that all dead weight will be taken off the axles. They will be permanently connected two in series, and on direct current the pairs will be operated on the series parallel system and on alternating current by means of voltage control.

Much interest attaches to this new electrical railway, which is the first to adopt electricity over the whole line. Judging from the experience of the Indianapolis and Cincinnati railway and others which are equipped on the Westinghouse single-phase system the results will in every way justify the choice.

The British Manufacturers' Exhibition in Egypt.

THIS exhibition, which was to have been held at Alexandria and Cairo at the end of this year, has been postponed until the end of 1906 and the beginning of 1907, because it has assumed very much larger proportions than was first anticipated. The exhibition will, it is proposed, be open a month in each city. The Committee are of opinion that the Egyptian public have never had a proper opportunity of knowing and seeing what can be produced in the United Kingdom and the Colonies, and therefore is unable to appreciate the excellence of their manufactures, with the result that cheaper Continental goods continue to be largely sold in Egypt, even in instances where the British articles would very probably supersede them were they more generally known.

Prospectuses and particulars may be had on application to the London agent, Mr. D. S. Murray, 11 and 12, Foster Lane, Cheapside, E.C., or direct from the secretaries at Alexandria, P.O. Box 423.

*

International Exhibition at Milan, 1906.

ITALY'S first great International Exhibition will be opened at Milan by the King of Italy on the 15th April next, in celebration of the completion of the Simplon Tunnel. The Exhibition will be on a large scale. The buildings will cover 42 acres and the grounds 200 acres. The British Government have voted £10,000 towards the equipment of the British Section, and Mr. Arthur Serena, whose offices are at 1 and 2, Oxford Court, Cannon Street, E.C., has been appointed Hon. Executive Commissioner.

The King of Italy will offer to exhibitors prizes to the value of £1,600, divided as follows :—

1.—A prize of £200 for automatic safety couplings for railway rolling stock.

2.—A prize of £200 for the best method of testing high voltage electric currents without danger to the operator.

3.—A prize of £400 for the best and most original exhibit of machinery or manufacturing process.

4.—A prize of £200 for the best established method of distributing healthy and pure milk in centres of population.

5.—A prize of £400 for the best type of popular dwelling adapted to the climate of northern Italy.

6.—A prize of £200 for motor boats.

In addition to the foregoing there will be given a national prize of £200 to the public institution or private society which, during the last ten years, has been most successful in the work of reclaiming waste lands in mountainous districts, and in the improvements of pasturage.

*

Widening the Tunnels, near Dawlish, G. Western R.

THE widening of the five tunnels near Dawlish on the Great Western main line was practically completed and opened to traffic on the 1st ult., thus making the line double throughout from Paddington to Plymouth.

This important work has been in progress about 3 years, and the five tunnels have been widened to take a second line of rails without in any way interfering with the traffic. This was accomplished by the use of steel shield arches 19ft. long, through which the trains ran while the tunnel was being enlarged all round it, and which were advanced as the work proceeded. The tunnels were originally constructed for a single broad gauge line. When the tunnel was completed it was only closed for 3½ hours while the new rails were got into position. The tunnels are through the red sandstone and lined with Staffordshire bricks set in cement.

*

"Graphite."

WE have received a copy of the special European edition of the "house journal" of the Joseph Dixon Crucible Co., entitled *Graphite*. Its contents are well illustrated and are of general interest to engineers. The most important works described are the Power House at Lots Road, Chelsea, the Car Sheds at Mill Hill Park, and other buildings connected with the electric railways controlled by the Underground Electric Railways Co. of London. Other important structures referred to are the London offices of the Shipping Combine (International Mercantile Marine Co., Ltd.) in Cockspur Street, the new Ritz Hotel in Piccadilly, and the new pier at Weston-super-Mare.

Books, Papers and Pamphlets.

Machine-Shop Tools and Methods. By W. S. LEONARD. London: Chapman and Hall, Ltd., 1905.

This work is primarily intended for the use of students who know little or nothing of machine-shop practice. It was originally issued in leaflet form in connection with the lectures to the students of the Mechanical Department of the Michigan Agricultural College, and of which the author is instructor. It has been much developed, and has been published in its present form as a text book for mechanical students generally.

The book is profusely and well illustrated with 689 photo reproductions and drawings, and, without doubt, the student who carefully studies its pages will be much better fitted to enter a shop, and will find things come to him much more easily than the student or apprentice who is not so prepared.

Even the experienced machinist or fitter, particularly those in charge of shops not equipped with the latest American tools, will, if he pass by the more elementary portions, find much to interest and possibly instruct him in the pages of this book, for it is always advantageous to compare the methods advocated and adopted by others with those practised in one's own shops.

The book is divided into short chapters, arranged in the following sequence. Measuring systems and gauges of all kinds are illustrated and their uses explained. Hammers, chisels, files, surface plates and scrapers, the vice and its accessories, are the subjects of successive chapters. The use of these tools, especially that of the file, cannot be acquired by reading, but the hints given will nevertheless be very useful for the beginner to remember.

Drilling machines, drills, their accessories, and the construction and use of reamers and bits are taken next, and are followed by several chapters dealing with the lathe and its chucks and tools in great variety, and which naturally lead up to screw cutting, nut and bolt screwing machines, and vertical and horizontal boring machines.

Planing, shaping and slotting machines are all discussed in turn, and prepare the way for the examination of general milling machines and special gear cutting and grinding tools. One of the last chapters is an excellent one upon the Interchangeable System of Manufacturing, and in which the use of jigs is explained.

As the book treats only of American tools and shop practices it is not to be expected that it is free from what we consider to be faults, or that we are prepared to admit that all the methods Mr. Leonard recommends are superior to those in vogue in this country. But taken as a whole it is a most excellent book, and we failed to find anything in it that would radically mislead a beginner.

*

Books Received.

Fowler's Electrical Engineer's Year Book and Directory for Light, Power and Traction Stations, 1906. Scientific Publishing Co., Manchester. [643pp.; 6ins. x 3¾ins.; price, 1*s.* 6*d.* net.]

Some 50 pages have been added to this useful annual in order to keep it abreast of the progress of electrical science. Amongst the substantial additions may be mentioned lengthy sections dealing with designing alternators, steam turbines and turbo-generators. Additional information is given as to the power and cost of electrical distribution, insulating materials, the Board of Trade rules, and the Home Office regulations as to the use of electricity in mines. The whole book has been subjected to its annual thorough revision, and where necessary whole sections have been entirely re-written so that its high and well-established reputation is fully maintained.

Electric Block Signalling on Railways. By W. J. THORROWGOOD. London: *The Electrician*, Salisbury Court, E.C. [Price, 3*d.*]

This is an 8-page pamphlet. It is a very elementary description of Electric Block Signalling. Two instruments—Preece's and Single Needle 3-wire—are illustrated, but the space at the writer's disposal was inadequate. The pamphlet is No. 80 of "The Electrician" Primers, which are being issued with a view of providing elementary introductions to the study of various electrical subjects.

How to See South Africa. The official guide of all the Railway Administrations of South Africa, and issued by their authorities. Compiled and published by Gilchrist and Powell, Ltd., Hatfield House, President Street, Johannesburg (P.O. Box 3182). [Price, 2*s.*]

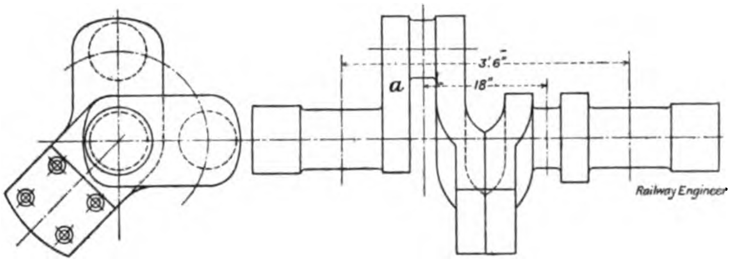
This is a most explicit, beautifully illustrated and interesting guide.

A Guide to Electrical Examinations. A handbook of reference for students and teachers together with an appendix of specimen questions and answers. By FREDERIC H. TAYLOR. London; Percival Marshall and Co., 26-29, Poppin's Court, Fleet Street, E.C. [118pp.; 7¼in. x 5in.; price, paper cover, 1*s.* net., cloth, 1*s.* 6*d.* net.]

Ivatt's Patent Crank Axle.

THE annexed drawing illustrates the new crank axle which has recently been designed and patented by Mr. H. A. Ivatt, M.Inst.C.E., locomotive engineer of the Great Northern R., and of which Messrs. Taylor Bros. and Co., Ltd., Clarence Iron and Steel Works, Leeds, are the sole manufacturers.

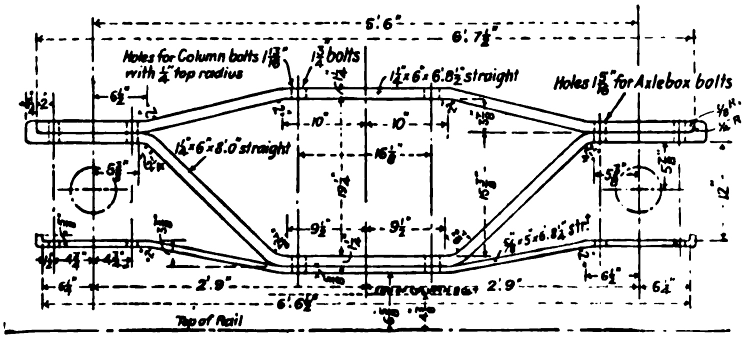
It will be seen that the axle is built up of two similar pieces bolted together in the middle through arms set at an angle bisecting that formed by the two throws of the cranks. The object of this arrangement is to secure greater flexibility, be-



cause with modern engines of large power the diameters of the crank pin and shaft are so large that there is no room for any spring in the outer webs at about the part marked *a* on the drawing. Moreover, the inner webs have been thickened until the length of shaft between them is too short to afford any flexibility. If one throw should fail it does not follow that the entire axle would have to be scrapped as in the case with ordinary solid crank axles.

Master Car Builders' Design for Diamond Frames of Bogies for Frieght Cars of 100,000lbs. Carrying Capacity.

THE annexed drawing accompanied the report which the Committee, consisting of Messrs. J. E. Muhlfeld (chairman), A. S. Vogt, W. T. Gorrell, C. E. Fuller, and F. M. Gilbert, presented at the last Convention of the Master Car Builders' Association and recommended for adoption as a standard for the bogies of freight cars and locomotive tenders carrying a total net and tare load of 150,000 lbs.



The dimensions given on the drawing are set out at length in the report together with the reasons for their adoption. Other dimensions conform to the present M.C.B. standards

The column bolts are 1¾in. diam. with heads 2¾in.

square by 1⅜in. thick, their total length from under the head is 24½in., and they are screwed for a length of 2½in. from the end. Their nuts are 2¾in. square by 1¾in. thick.

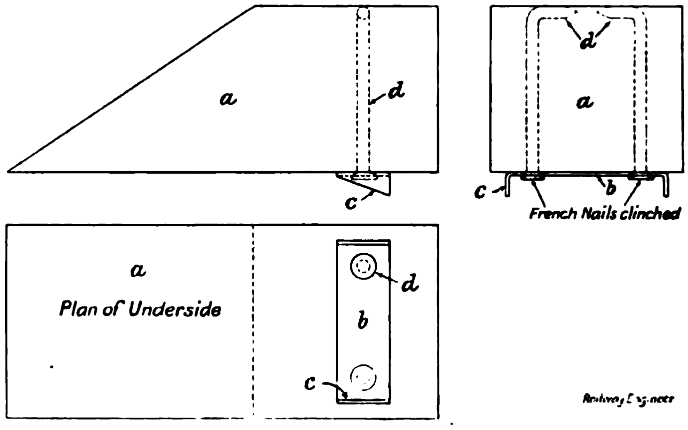
The material recommended for the diamond frame or arch bars, tie bar and column bolts is good wrought iron, as it is better able to stand distortion without fracture, but when the best quality of wrought iron is not obtainable then "a "good medium carbon low phosphorus and sulphur, open-" hearth steel can be used for arch and tie bars. The use of "Bessemer steel is not recommended under any circum-" stances."

The iron should be "made of tough fibrous wrought iron, free from admixture with steel scrap," and have a tensile strength of from 47,000 to 53,000 lbs. per sq. in., with an elongation as rolled of not less than 16 per cent. in 8ins., or when reduced to a test specimen a tensile strength of at least 46,000 lbs. per sq. in., with an elongation of 15 per cent. in 8ins. When nicked and broken by light blows the fracture "must show a generally fibrous structure free from admixture of steel." The bars must bend double (through 180°) hot or cold over a mandrel of the same diameter as the thickness of the bar.

The steel must contain less than 0·60 per cent. of phosphorus, 0·45 per cent. of sulphur and 0·80 per cent. of manganese; have tensile strength of not less than 50,000 or more than 65,000 lbs. per sq. in., and an elastic limit of 30,000 lbs. When the tensile strength is between 50,000 and 60,000 lbs. it must have an elongation of at least 26 per cent. in 8ins., and when it is between 60,000 and 65,000 lbs. the elongation must be at least 24 per cent. in 8ins.

Lockie's Non-skidding Scotch.

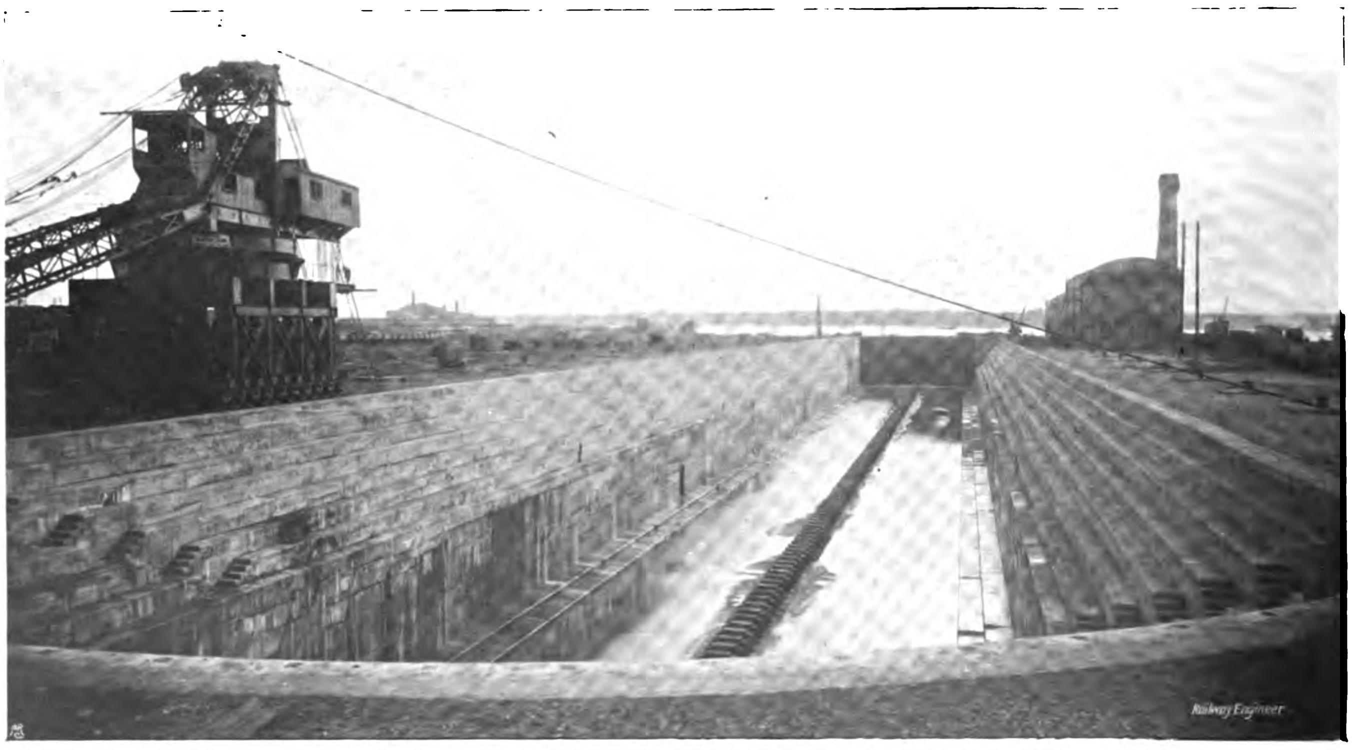
THE annexed sketch illustrates a Non-skidding Scotch or Wedge which has been patented by Mr. W. Lockie, 17A, South Castle Street, Liverpool, and which has already been largely used by railway companies. It consists of a piece of rough wood sawn to shape with a strip of steel *b*, the ends of which are turned up to form saw-tooth points *c*, securely fastened on to the under side by clinched French nails *d*. The object of this little device is to securely "scotch" barrels and such like in railway wagons, carts, warehouses, &c., and thus do away with the use of straw



whisps or ordinary wedges nailed to the floor—practices which have many disadvantages. We understand that four of the large French railway companies have purchased hundreds of thousands of these scotches, and that they are also extensively used on the Midland, the North Eastern, the L., Brighton and S.C., and several other British railways. Mr. S. Stone, 75, Finsbury Pavement, E.C., is the London agent for these scotches.

"Trafalgar" Graving Dock at Southampton.

THE accompanying is an illustration of the magnificent graving dock just completed at Southampton by the L. and South Western R. Co., and which was opened by the Marquess of Winchester on the 21st ultimo. This dock, one of the largest in the world, is amply capacious for the biggest vessels afloat or building. Its principal dimensions are: Length, from point of cill to dock head, 875¼ft.; length occupied by keel blocks, 839ft.; width of entrance, 90ft.; width of



New Graving Dock at Southampton; L. and South Western Railway.

dock at floor level, 90ft.; width of dock at cope level, 125ft.; depth of dock from cope to floor, 43ft.; depth of water over cill at high water of spring tides, 33ft.; depth of water over cill at high water of neap tides, 29½ft. Since they took possession of the dock property in 1892, the South Western R. Co. have reclaimed an area of nearly 100 acres, formerly known as the "Mudlands," and the new dock, approached directly from the estuary of the river Test, stands upon the northerly portion of this land, in an exceedingly convenient situation. It is built almost entirely of Portland cement concrete, 133,000 cubic yards of which material has been used. The dock holds 85,000 tons of water, but can be emptied by two centrifugal pumps in 2½ hours. The entrance gates are covered by greenheart timber meeting faces, and 250 tons of steel is contained in each leaf. They are opened and closed by powerful direct-acting hydraulic rams, made by Armstrong, Whitworth and Co., Ltd.; and the plant provided for graving purposes includes a travelling electric crane—the largest in existence—capable of lifting more than 50 tons at a radius of 87ft. This enormous steel structure will be invaluable to ships of war, as well as to passenger steamers, for which Southampton has now made such excellent provision, including no fewer than six graving docks.

• Edison Primary Batteries for Operating Automatic Signals.

THE published accounts of the automatic signals on the North Eastern R. and the London and South Western R. do not give a description of the batteries used to operate the signals, and which are the "S S" type of the Edison Primary Battery (formerly known as the Edison-Lalande), supplied by the Edison Manufacturing Co., of New York.

The battery is illustrated by fig. 1, with a part of the porcelain jar removed to show the interior of the cell. It consists of two copper oxide plates, suspended one above the other, in a frame, the sides of which are grooved and pass through the porcelain lid of the jar, and are secured by two outer nuts. The copper plates are slid up the grooves from the bottom, and each is supported by a copper rod passing through the channel sides of the frames and secured by nuts as shown. Between the top of the upper copper plate and the lid of the jar hollow hard rubber insulators are placed on the frame sides, to prevent leakage of current between the stems of the zinc plates and the frame sides at the surface of the solution.

Each battery has also two zinc plates, between which the copper plates are held. The zinc plates have bent stems, which pass through the lid of the jar, and are secured on either side of the porcelain knob of the lid with a brass bolt passing through.

The solution consists of 20 per cent. of caustic soda and 80 per cent. of water. A small quantity of oil is placed on the top of the solution to prevent creeping and evaporation. The proper quantities of soda and oil are supplied by the makers. The inside of each jar is marked to indicate the height to which it is filled with water.

The amount of copper oxide used in each cell is so calculated that it will be entirely reduced to metallic copper simultaneously with the zincs and the exhaustion of the solution.

It is apparent from the illustrations that the battery is very simple in construction and is readily renewed. New copper and zinc plates can be fixed in position, the old solution thrown away, new put in, oil added and the battery be again ready for work and as good and as effective as when it was new, in a very few minutes, at a cost of $1.45.

One of the chief points of superiority claimed for this battery is the absence of local action when not in actual service, and it is stated that in an actual test made with 40 of these cells it was found that the average loss in zinc in each cell, for a period extending over three months, was a fraction over 1 per cent. per month.

Fig. 1.

It is also claimed that this battery requires no attention until the charge is entirely exhausted; that it generates no noxious or poisonous fumes, that its permanent parts do not deteriorate with use, and that extreme frost has no effect upon it.

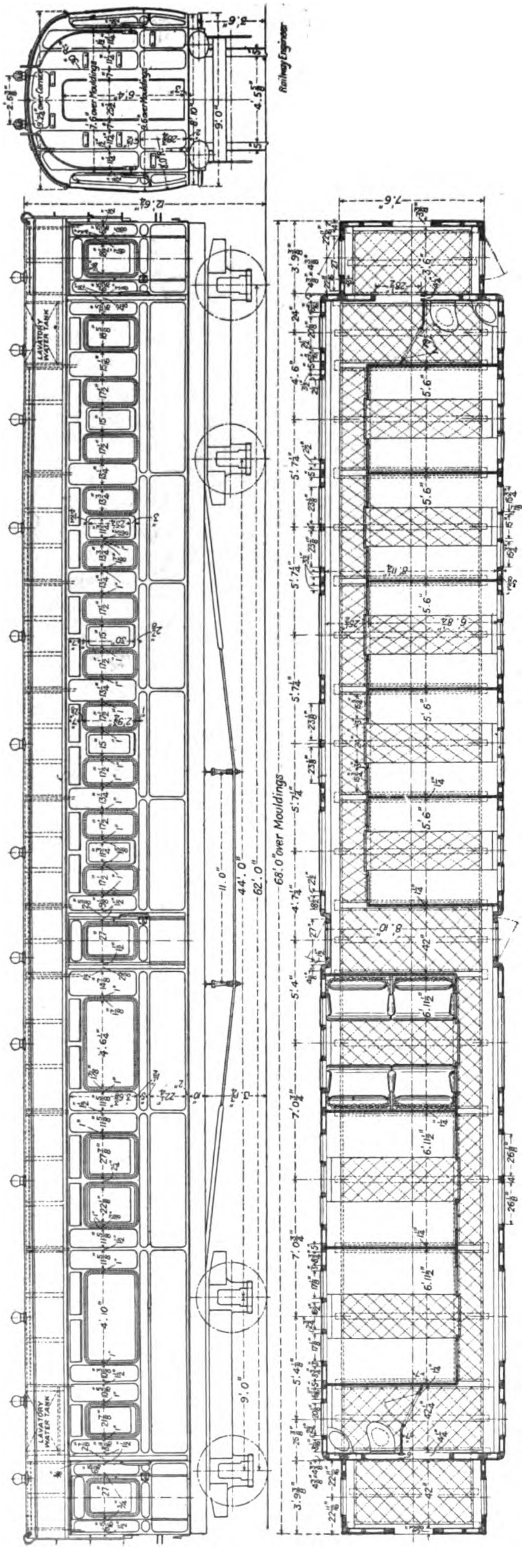
The type "SS" cell has a capacity of 300 ampere hours. Its size over all is 6¾ins. diameter and 12¾ins. high.

Some signal engineers on American railways are working their signals from storage batteries, but it does not yet seem proved that this course is cheaper than primary batteries. It cannot be applied unless there be some power near to generate electricity, and therefore could not be used for the automatic signals on the North Eastern R. unless portable storage batteries were used, but these are costly and inconvenient.

Composite Corridor Carriages; Great Western Railway.

THE annexed drawing illustrates the Composite Corridor Carriages especially designed by Mr. G. J. Churchward, chief superintendent of the locomotive carriage and wagon department, Great Western R., for the "limited" express trains between Paddington and Penzance. These trains have only two classes, viz., 1st and 3rd, and the carriages illustrated, of which there were two on each train, have three 1st-class and five 3rd-class compartments.

The arrangement of the corridor is quite novel. It crosses from one side of the carriage to the other, the object being to provide "outside" corner seats on both sides of the train, but it also distributes the weight more evenly, and therefore tends to promote steady running. The outside windows of the corridors are, as shown on the drawing, of large size, in order not to obstruct the view from the carriages more than is absolutely necessary.



Composite Corridor Carriage ; Great Western Railway.

These carriages are 68ft. long over the mouldings, 48ft. 6in. between the centres of the bogies, which are 4-wheeled and have a wheel base of 9ft. The other carriages which made up the "limited" expresses are longer, viz., the two 3rd-class brakes and the dining car 70ft. and the 3rd-class carriage 69ft. These carriages have the distinction of being (together with some others on the Great Western R.) the longest vehicles in the world running on 4-wheeled vehicles. They are also the widest main-line carriages in this country, being 9ft. 6in. at the waist over the mouldings, 9ft. 8¼in. at the cornice, and 8ft. 10in. at the bottom sides. Their height inside from floor to ceiling is 8ft. 0$\frac{11}{16}$in.

The roof is of the elliptical shape introduced by Mr. Churchward, and which is now becoming fairly common on Great Western trains. It gives a greater cubical capacity to the inside —a welcome improvement on long journeys—it is easier to construct and much easier to keep clean than the clerestorey pattern. It also gives immunity against the claims arising from condensed moisture on the clerestorey lights running over the ledge, which may happen to be dusty, and dripping on to expensive ladies' dresses beneath.

The compartments, on account of the width of the bodies, have no side doors, but the corridors are entered from the ends and at the middle of the carriage through vestibules with the doors set back, as shown. The drop lights are guarded with brass bars.

The interior appointments and upholstery of these carriages does not differ materially from the high standard in vogue on Great Western ordinary corridor stock, and which may be briefly described as tasteful, highly finished, comfortable and substantial. Since Mr. Churchward took office he has given particular attention to all details likely to affect the hygienic condition of the carriages, and ornate decorations and mouldings, ledges and corners likely to harbour dust have been, as far as possible, abolished, and the cleaning proportionately simplified.

The ceilings are divided into panels, filled with 3-ply birch wood wrought to a fine surface or lincrusta and painted with white "flat" enamel. The joints are covered with plain narrow mouldings lined out with gold and colour according to class. The result is restful to the eye, it is kept clean with a minimum of labour, and does not absorb the light.

The first-class compartments are upholstered in dark coloured (green or blue) cloth trimmed with handsome laces. The fascias, door frames, &c., are of polished American walnut with white enamel end and side panels. The floors are covered with thick rugs. The smoking compartments are upholstered with morocco leather.

The third-class compartments are furnished with woven wire seats, covered with wool rep or leather, and the floors are laid with "kork." The partitions and sides above the nets are grained oak.

All compartments are decorated with framed views of places of interest on the G.W. system.

The first-class corridors are finished with polished V-jointed slats, American walnut below the lights and sycamore above; the doors are framed in walnut with sycamore panels. The third-class corridors are grained, the doors and frames being of polished oak. The lavatories are lined with "emdeca."

The carriages of the "limited" trains are fitted with the Lucas-Leitner system of electric lighting, and which we illustrated and described fully in our issue for last May. The carriages are well provided with air extractors on the roof to promote ventilation, and are also fitted with steam heaters under the seats, and which may be shut off by the passengers by means of a handle fitted in the compartment.

Reinforced Concrete.—V.

Columns.

The strength of Portland cement in compression is nearly equal to that of the best building stone, and there is the advantage that it can be laid in a monolithic mass without the joints that are necessary in all stone columns except those of very small sectional area. The tensile strength is, however, comparatively small as in the stone. When, however, steel rods are embedded in the mass of the concrete the allowable deformation of the material is increased some fifteen times.

Economy of space in most warehouses and other buildings will require that the area of the column shall at least not be greater than if it were constructed as a steel stanchion protected by a fire-resisting covering of tile or terra-cotta.

In nearly every case columns are liable to flexure as well as direct compression, and hence it is desirable that the reinforcement shall be distributed as near as possible to the outer surface of the column, in order that it may more effectually meet the tensional stresses that occur at the outside surface. It is a great advantage to have the concrete restrained laterally by winding it with wire or spiral hoops. In some systems of reinforced concrete work this is provided for by means of a riveted ring around the vertical rods, and where beams rest on the columns it is an advantage to extend the vertical rods, or some of them, and bend them outwards into the horizontal beams, and so increase the rigidity of the structure and at the same time provide against shear at these points. Brackets between the column and the beams to reduce the angle are also very desirable, and in most cases are provided. The concrete should be of the consistency of brick mortar, and should require no tamping.

The columns for the steel-concrete shops of the United Shoe Manufacturing Co. at Beverly, Mass. (fig. 1), are of a total height of about 62ft. for the four stories and ground floor, and are 20 ft. apart. The section of all the columns in plan is octagonal and the diameter varies from 22ins. in the ground floor to 8ins. in the top story. Each of the columns has eight $\frac{3}{4}$in. vertical bars in its section, and as these are lapped 12ins. and spliced at just above the floor level in each case by a sleeve of $\frac{3}{8}$in. by $\frac{1}{4}$in. steel, closely coiled throughout the overlap, the rods may be said to be practically continuous from top to bottom of the column. A helix of $\frac{3}{8}$in. by $\frac{1}{2}$in. steel rod formed with a 4ins. pitch is formed around the inner surfaces of the vertical reinforcing rods.

The wooden moulds for the columns were made of 4ins. by $1\frac{3}{8}$ins., mitred together at the angles, and these were supported by rectangular cross frames made of 6ins. by 3ins. scantling, about 2ft. 6ins. apart vertically. The concrete surfaces in the interior of the building were painted white, giving a very satisfactory appearance.

The Bilgrim machine shop at Philadelphia (fig. 2) was arranged for five stories in the total height of 53ft. The basement is 10ft. high, floor to floor, and the other floors vary from 14ft. 8ins. to 10ft. in height. The columns in the basement are 26ins. square. For the floor above the columns are 21ins. square, for the second floor 19ins. square, for the third floor 17ins. square, for the fourth floor 13ins. square, and those in the fifth floor, which supports the roof, are 8ins. square. The maximum unit compressive stress in the concrete allowed was 500 lbs. per square inch, no allowance in this case being made for the reinforcement of the columns. In the longitudinal direction the columns are 14ft. 4ins. centres, and transversely 18ft. 6ins., and in both directions girders connect the columns together at the floor level. The concrete was composed of 1 part Portland cement, 3 parts gravel, and 5 parts of broken trap rock that would pass through a $\frac{3}{4}$in. ring.

The internal columns of the Thompson and Norris Co.'s factory at Brooklyn are circular in section, and vary in diameter from 28ins. in the basement to 12ins. at the top. They were made in moulds of No. 10 expanded metal with 3ins. mesh, curved cylindrically and with wired joints, and inside each cylinder are four vertical rods, 1in. diameter in the basement, reducing to $\frac{1}{2}$in. in the sixth story. In all cases the rods project a couple of feet above the floor level of each story, and at this point they are spliced by four $\frac{1}{2}$in. rods or fish bars four feet long, which are thoroughly secured by 3-16in. wire wrapped around their entire length. The vertical rods were arranged to resist the lateral or bending only of the column, whilst the concrete was assumed to be able to carry a maximum compressive stress of 750 lbs. per square inch. The columns were covered by a $\frac{5}{8}$in. coating of cement mortar. A sketch of the base of one of the columns is given in fig. 3, and it will be noticed that the foundation was reinforced with rods in order that it might resist as a cantilever, and that the base of the column projects all round to give it a better and increased bearing on the foundation.

The warehouse of the J. M. Bour Co. at Toledo, Ohio, has columns running up through the height of four stories. They were in the form of squares chamfered at the four corners, and were 20ins. at the lowest story, 19ins. above in the first and second stories, 16ins. above in the first and second stories, 16ins. in the third and 10ins. in the fourth and top story. The spacing of the columns was 16ft. 6ins. in both directions. Where girders rest on the columns corbels or brackets were formed of the same width as the thickness of the girder. The corbels were 12ins. long and were reinforced with rods parallel to the inclined face. As all beams were assumed to be fixed at their ends to the columns special reinforcing straight rods were placed at the level of the top of the beams and were made to extend on each side of the columns over one quarter of the span of the beam. In the design of the columns it was assumed that the concrete would take a stress of 350 lbs. per square inch, metal being added for theoretical deficiency in strength. It is interesting to note that the moulds of the columns were at first filled in only about 6ft. of their height, but it was found tha he slight coati g of cement around the upper length of rods prevented the essential adhesion of the succeeding concrete laid around them.

The Robert Gair warehouse in Brooklyn is an important building of eight stories and a basement, each 13ft. 4ins. in height. The footings of the interior columns are 12ft. square, but varying in thickness from 3ft. 4ins. at the centre to 6ins. at the edges, and the concrete is reinforced here by 1in. rods spaced 9ins. apart in two courses at right angles to each other at a distance of 3ins. above the bottom. In the base of the columns are placed 1in. rods 3ft. long, this length being arranged half into the footing and half up into the base of the column. The columns vary in size from 27ins. square in the basement to 10ins. in the eighth story, and the reinforcement commences with eight $1\frac{1}{4}$ins. round rods in the basement, 3ins. from the surface, and continues in this man-

ner in the first story, but in the second and third stories six rods only are adopted and four in the stories above, the diameter of the rods in the last case being but ¾in., at a distance of 2ins. from the surface. The columns are square in cross section, with corners rounded at 2ins. radius, and in all cases the ends of the bars are connected by a sleeve. In the basement the vertical rods are hooped with ¼in. rods every 4ins. of vertical height, diminishing to 10ins. apart in the eighth story with 3-16in. rods.

The late experiments of Professor Caustland, of Cornell University, on reinforced concrete columns, are of much interest in this consideration. A series of columns 40ins. long by 10ins. diameter were arranged, some without reinforcement at all, some with vertical rods embedded in the mass with a few hoops, and others with a series of hoops close together. Upon testing these it was found that whilst the columns made of concrete alone had an average breaking load of 115,000 lbs. per sq. in., those bound round with hoops only had an ultimate breaking load of 214,600 lbs. per sq. in., and it was further discovered that the binding of the material by means of the hoops was far more effective in strengthening the concrete column than the arrangement of vertical rods alone.

Walls.

The walls of the Parkville sub-station of the Brooklyn Rapid Transit Co. are a typical example of reinforced concrete construction. A series of pilasters or columns were made in the first instance with slots left in their sides (fig. 4) to engage with filling-in or curtain walls that were put in at a later date, and are virtually thin slabs of concrete acting only as weather protection. A travelling crane with runners was provided for also by special girders against the wall, and at each of the wall pilasters an inside buttress or column was formed as an integral part of the wall to carry the crane girders above it. The pilasters are 3ft. by 1ft. and are reinforced by six rods, each ¾in. diameter, and by horizontal tie bars of a less size. The wall slabs are 8ins. thick and have tongued and grooved joints into the pilasters. They are reinforced throughout by 5-16in. vertical and horizontal rods. Over the door and window openings a lintol is formed, and this is provided with special reinforcing rods bonded at the ends, although the lintol is made as a part of the wall slab. The walls were constructed in panels 14ft. long by 3ft. high between the pilasters, and were subsequently covered with a coat of cement mortar of 1 to 2½ proportions. The bond between the pilasters and the wall slabs was assisted by means of horizontal rods 2ft. long and 5-16in. diameter, built into the pilaster and left projecting for the subsequent filling in.

The Thompson and Norris Co.'s factory at Brooklyn has a total height of 72ft., the outer walls being composed of a series of wall columns rectangular in plan, with dimensions varying from 20ins. by 26ins. at the lowest story to 10ins. by 18ins. at the top story, diminishing by means of offsets at each floor. Four corrugated bars varying from 1¼ins. at the base to ½in. at the top story are embedded in each of the rectangular columns, and these bars are spliced at each story at a point 2ft. above the floor level. The filling in between the wall columns is 8ins. thick at the bottom and 6ins. at the top, and forms an integral part of the construction with the columns. The corner wall columns are L shaped, and have five vertical bars, and in each case the bars are wired together spirally, 6ins. pitch with 3-16in. wire, or are wired to rectangular horizontal ¼in. frames spaced at 12ins. centres vertically. The windows fill about one half of the entire wall surface, and are made of wire glass set in metal sashes.

The warehouse of the J. M. Bour Co., Toledo, Ohio, is four stories in height, and is divided into three sections by concrete partitions only 4ins. thick. For the reinforcement vertical bars 1½ins. by ¼in. were placed 16ins. apart, with round bars ⅜in. diameter, 6ins. apart, wired to the vertical bars. The horizontal rods were placed alternately on each side of the vertical bars, with their ends built into the columns. This partition carries the weight of the adjoining floors, and was built at one operation with the floors themselves.

The walls of the Robert Gair warehouse at Brooklyn are nine stories in height, and consist of 8ins. curtain walls, in which are large window areas, with metal frames and wired glass. At 16ft. or 18ft. centres are placed wall columns or piers rectangular in plan and in size 2ft. by 4ft., varying through the height to a thickness of 1ft. 4ins. Each of the wall columns is reinforced with four vertical rods, 1in. for the first story, diminishing to ½in. in the top story. At the bottom of the wall the vertical bars are hooped with ¼in. bars at 12ins. distances, varying to 15ins. centres at the top. In each case the vertical bars rest on cup-shaped castings designed to distribute the weight over the footings. Over the windows are wall beams or lintols 1ft. 6ins. by 10ins. wide, with four ¾in. rods along the lower surface for reinforcement. The pilasters in the walls were tooled for the sake of appearance, whilst the face of the curtain was left plain as it left the forms.

The shops of the United Shoe Machinery Co. at Beverly, Mass., have walls made up of columns rectangular in plan, girders over the openings and a deep cornice, of which fig. 5 shows some of the details, and of window area. On one side of the building the piers are hollow for use as hot air flues which communicate with hot air chambers in the walls, as shown in the sketch. The wall piers or columns are reinforced with four vertical rods ⅜in. diameter, continued from the basement up to the parapet. At each 2ft. in the vertical height ¼in. bars are placed horizontally, and galvanised steel strips are also embedded in the concrete to keep the wooden window frames in position. The wall piers or columns go down and finish on to a footing 5ft. by 5ft. and between these footings the wall is made solid and is reinforced in the usual manner to form it into a beam or girder. The wall columns are 20ft. centres throughout the length of the wall. The partitions in this building are generally 4ins. thick and the area of the slab is about 20ft. by 14ft. In this thickness vertical bars ¼in. thick are placed at distances of 3 ft. apart and staggered in such a way that the rod is ½in. away from the face of the partition on alternate sides of the slab. On the inner side of these vertical bars are wired horizontal bars also ¼in. thick, and in like manner staggered to go alternately to the two faces of the partition. On each side of the openings two ¼in. bars, and at the corners one ¼in. bar is placed, with one ½in. bar over each doorway. The vertical bars in the partitions go down and up into floor and ceiling, so as to form dowels that hold the partition in its position.

Retaining Walls.

The section of the retaining wall shown in fig. 6 was built in Indianapolis and is 300ft. in length, but is to be extended yet another 600ft. The reinforcement consists of ½in. cor-

rugated bars, laid horizontally at the front, back and base of wall, spaced at one foot centres throughout. The vertical rods in the front of the wall are of the same description as the horizontal bars, but are spaced at two feet centres, those in the back and inclined surface at the heel being spaced at one foot centres. From an English engineer's point of view this wall seems to be extremely thin, and it would appear that the ground both behind and under the wall must have been of a very satisfactory nature to have justified the design.

The Thompson and Norris Company's factory at Brooklyn has vault or retaining walls (fig. 7) stiffened inside with buttresses, or pilasters, and provided at the top of the wall with a reinforced concrete beam to support the footway over the vault. The footings project some distance inside the wall and are designed to act as cantilevers under each of the butresses. The bars are ½in. in diameter, four being placed at the top of the concrete cantilever and seven at the lower surface. Between the projecting buttresses the wall consists of a simple reinforced concrete slab.

The retaining wall of the Philadelphia Rapid Transit Company, under Market Street (fig. 8), is vertical at the back, but inclined ¾in. in the foot on the face, and is 3ft. 6ins. in thickness at the top. At a distance of 6ins. back from the rear

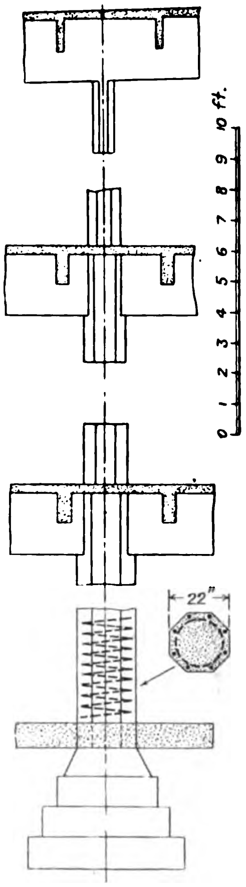


Fig. 1.

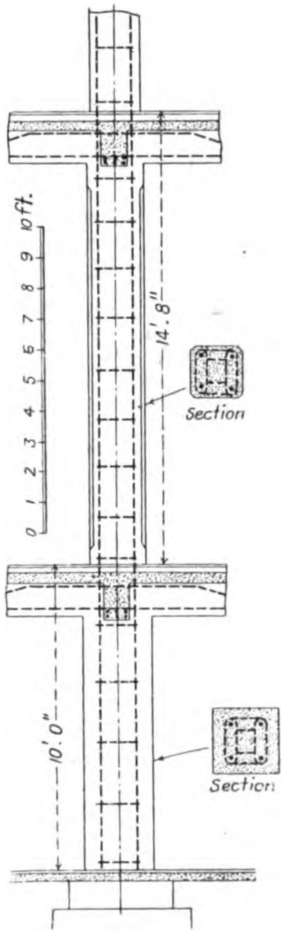


Fig. 2.

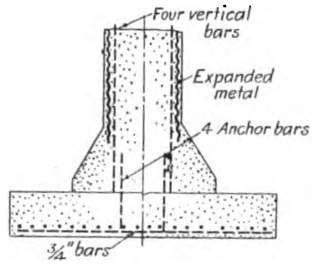


Fig. 3.

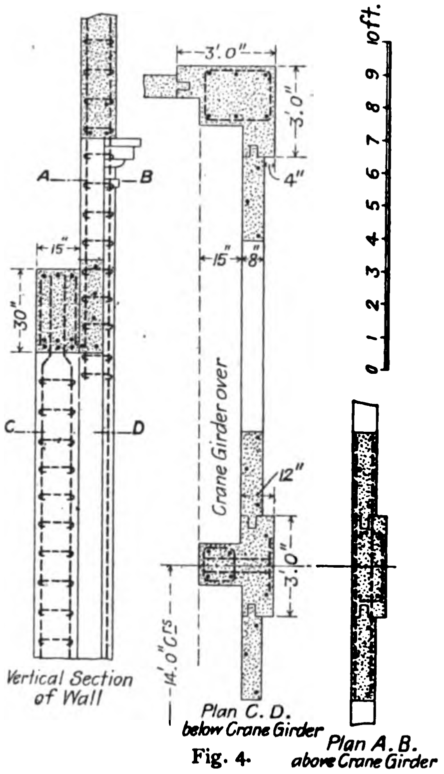


Fig. 4.

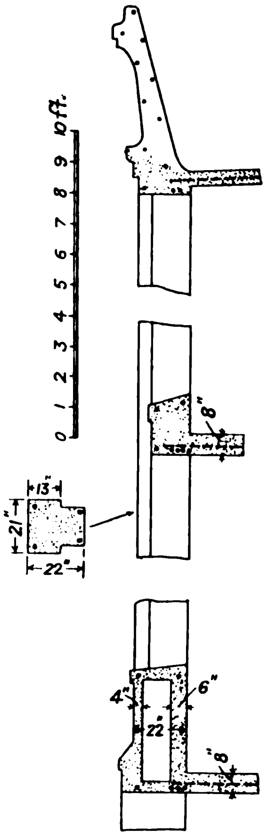


Fig. 5.

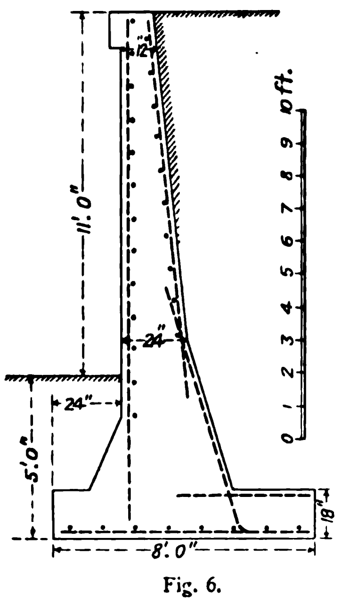


Fig. 6.

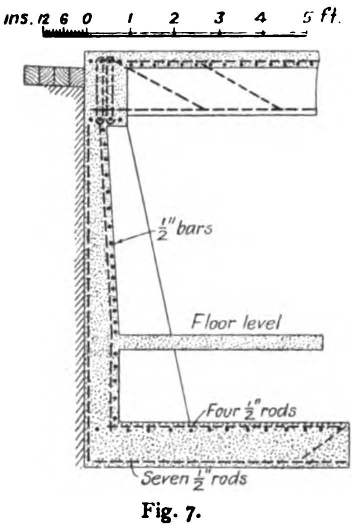


Fig. 7.

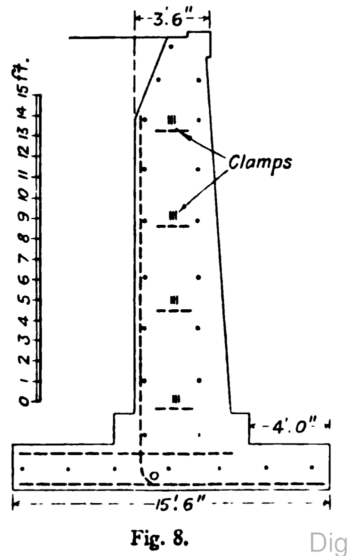


Fig. 8.

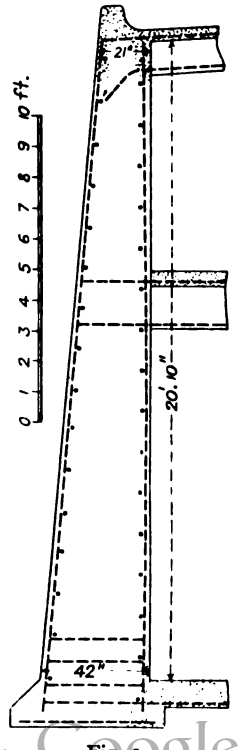


Fig. 9.

of the wall ⅞in. reinforcement rods are placed vertically at 8ins. centres, and are curved at the foot into the horizontal position, where they continue until 6ins. away from the toe of the footing. At the bend the vertical rods are curved round a 2½ins. gas pipe as indicated in the figure, the rod being wired to it. Alternate with the horizontally bent continuations of the vertical rods are placed ⅞in. horizontal rods 10ft. long. Other horizontal rods at right angles to the plane of the cross section of the wall are laid in as shown in the sketch, spaced at 2ft. centres apart vertically. Where different sections of the retaining wall join each other an interesting feature is a series of clamps spaced at 3ft. centres vertically. One plate is embedded in the concrete of one section and two plates are fixed likewise in the next section in such a manner that the arrangement is that of the tongue and groove, a method that was designed to prevent lateral movement of one section from another, but at the same time intended to permit the inevitable unequal settlement of the two sections.

The outer wall of the coagulating basin of the filtration plant at Marietta, Ohio, may perhaps be included as an example of a retaining wall, and was designed not only as a cantilever to resist the pressure of the water but also as a beam to resist the force of the water which was assumed to be concentrated at a point at one-third the depth of the water, the lower floor and the roof being assumed to provide the necessary reactions for the beam. The wall is 3ft. 6ins. in thickness at the base and 21ins. thick at the top, the inner face being vertical and the outer face inclined. Vertical rods (fig. 9) are placed in the concrete, ⅞in. diameter and 6ins. centre, on both sides of the wall 3ins. within the surfaces At the same time horizontal rods, ⅝in. diameter and 16ins. centres, are also provided. At the corners of the building additional rods, ⅝in. diameter and 8ft. long inside, 16ft. outside, were arranged horizontally on 15ins. centres inside the vertical rods.

Passenger Car Paint Shop and Varnish and Cleaning Rooms; Lake Shore and Michigan Southern R.

THE varnish and cleaning rooms of the passenger car paint shop, fig 1, at the Collinwood shops of the Lake Shore and Michigan Southern R. are especially well arranged. In the cleaning room, which adjoins the main shop on the south end, is to be found a novel system of tanks for washing sash and other parts of the woodwork of passenger cars under repairs. The question of supplying sufficient tank room for this work on so large a scale and in such a manner that it shall be easily accessible has been very successfully met by the system illustrated by fig. 2. Sectional tanks, not only simple of construction but also easy to repair when same is necessary, have been adopted.

There are eight of these washing tanks, each of which is built up of sections, figs, 1 and 2. Each tank consists of three middle sections and the necessary two end pieces, all of cast iron, which are bolted together, making a tank of great strength and durability. This method of erecting them effected a very material saving in the pattern work for the castings, and if by chance any section is broken a new one can be bolted in place of the broken one with comparative ease. The method of erecting them, as well as of supporting them upon the iron framework stands, is well shown in the drawings.

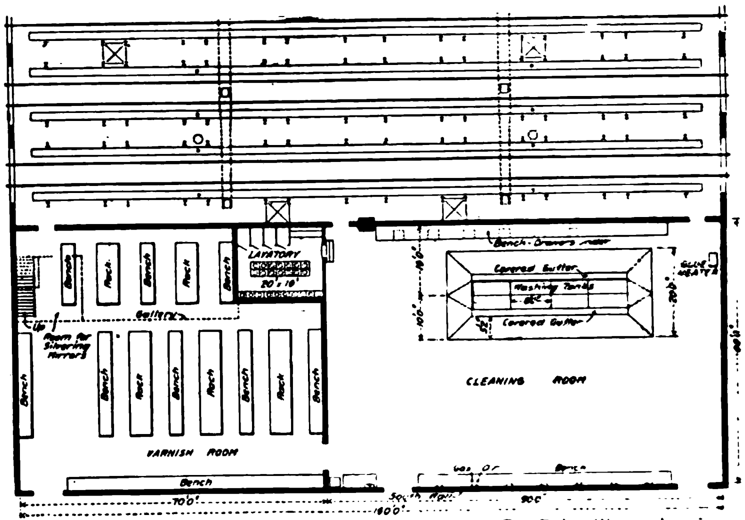


Fig. 1.—Detail Plan of South end of the Passenger Car Paint Shop, showing arrangement of Cleaning and Varnishing Rooms

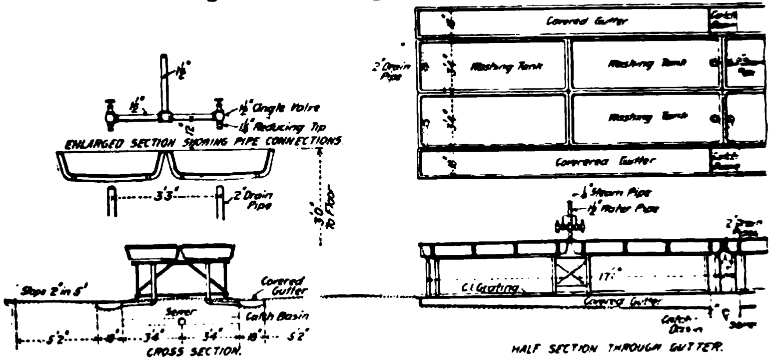


Fig. 2.—Details of the Sectional Washing Tanks.

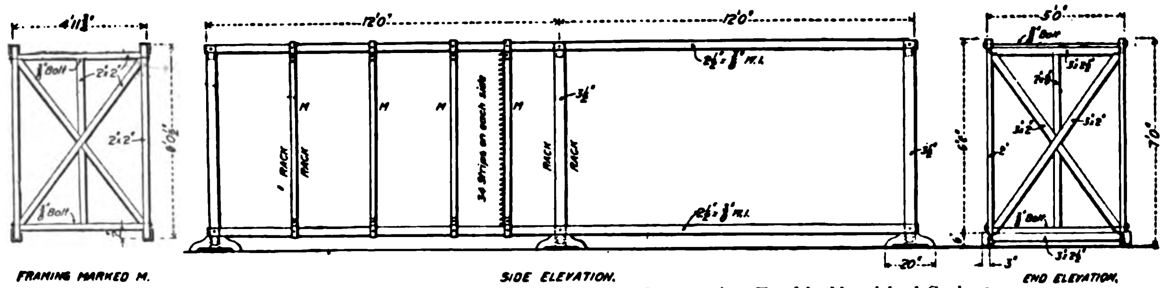


Fig. 3.—Construction of the Adjustable Rack System for carrying Freshly Varnished Sash, &c.

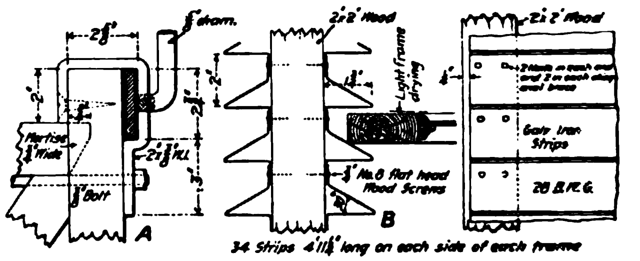


Fig. 4.—Details of the Special Corner-piece Clamps for securing the stanchions and of Triangular Galvanised Iron Supporting Strips.

In front of each row of washing tanks is located a covered gutter for draining the drip from washed pieces to the sewer. The floor slopes toward this gutter for more than 5ft. back from it. Each tub is piped up for water supply and also with a steam connection for delivering heated water; this is accomplished by injecting the steam, from the ½in. pipe, as shown, into the water pipe, while the cold water is running from the tap, the steam being led into the water pipe through a special mixing connection in a tee fitting.

The plan of the varnish room, fig. 1, indicates the locations of these racks, of which there are three, each 24ft. long and 5ft. wide. The peculiar shape of the supporting strips B, fig. 4, is such as to carry a sash by contact at a corner only, so that the freshly varnished surface is not interfered with. These racks are each located between the varnishing benches, so that the work may be placed directly in the drying rack after varnishing.

For the support of freshly varnished doors a different system of racks is adopted. This is a standing rack (fig. 5), consisting

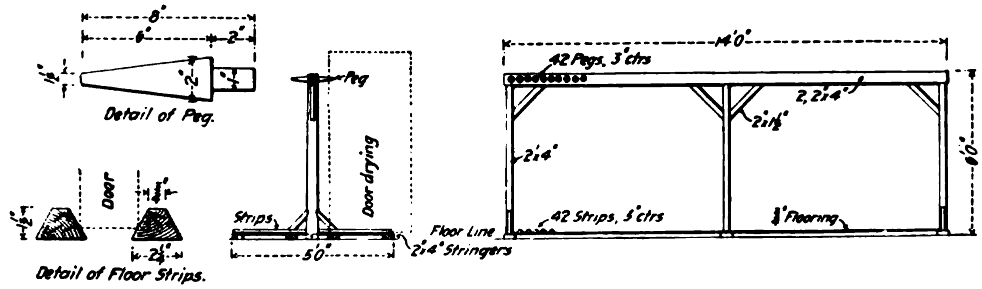


Fig. 5.—Details of Arrangement and Construction of the Rack System for Supporting Freshly Varnished Doors.

Another feature which is of interest is the system of racks used in the varnish room for storing window sash and blinds while drying. This arrangement of racks (figs. 3 and 4) provides a most efficient means for storing the entire equipment of a car while drying, so that the least possible amount of room is required. It consists of a long framework of iron bars, as shown in the accompanying engraving, with adjustable stanchions, which may be arranged to accommodate any width of sash or blinds. The stanchions, or movable partitions, are merely slid along the iron bar guides, and, when properly spaced, are clamped securely by a binder at each corner. (A, fig. 4).

of a floor frame piece with strips running crosswise having bevelled edges; above this is erected an elevated longitudinal supporting stringer with projecting taper pegs. The door rests between two of the strips on the base and between two corresponding pegs above; in this way the door will be supported entirely by edges and the freshly varnished surface is protected. Each of these two door racks is 14ft. long and the elevated supporting stringer is located 6ft. above the floor. Each rack has a capacity of 54 doors upon either side of the stringer, making the total capacity 108 doors.—*American Engineer and Railroad Journal.*

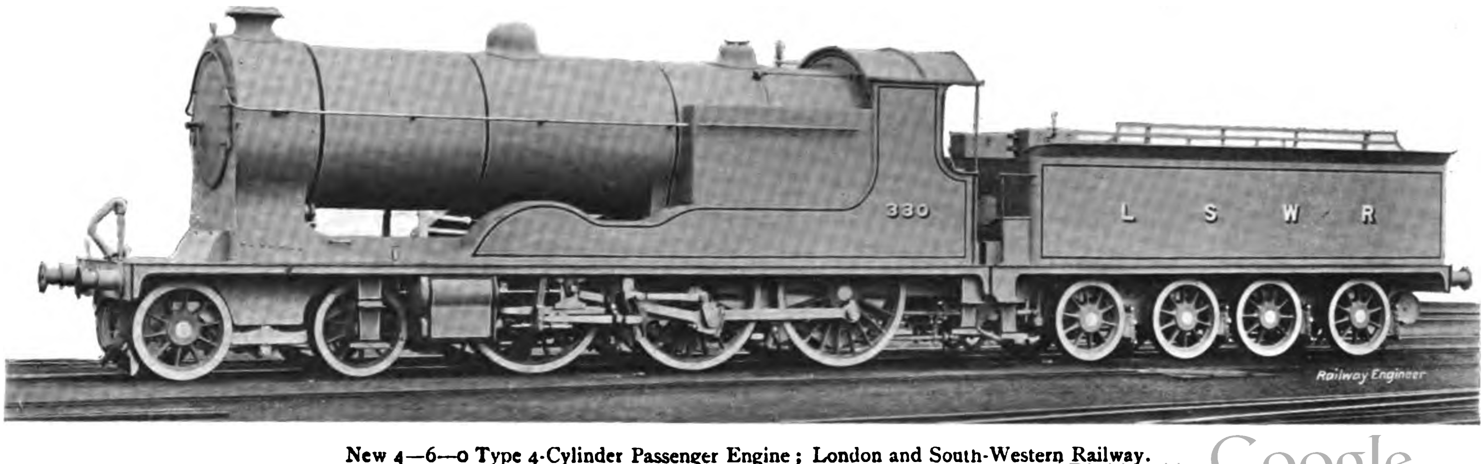
Four-Cylinder 6-Coupled Express Engine; London and South Western Railway.

THE latest type of passenger locomotive introduced by Mr. D. Drummond, M.Inst.C.E., chief mechanical engineer of the L. and South-Western R., for working heavy and fast trains on that line are of the 4-6-0 type, with four single-expansion cylinders arranged in pairs, one inside and the other outside the frames, each pair driving a separate axle.

The design is illustrated by the accompanying photograph, for which we are indebted to Mr. Drummond. Walschaerts' valve-gear is employed for actuating the valves for the outside cylinders, which are placed at the rear of the bogie, and drive the intermediate coupled wheels. Valve motion of the ordinary Stephenson pattern is used for the inside cylinders, which drive on to the crank axle of the leading coupled wheels.

The boiler is of very large proportions; indeed it could not very well be made larger whilst still retaining the ordinary form of mountings, and upon this feature of the design the success of the engine will largely depend, for the cylinders have an aggregate capacity equal to that of two of 22ins. diam. by 24ins. stroke, without of course possessing a wider range of expansion than would be obtained with the two-cylinder type.

The engine, which ranks among the most powerful in passenger service on British railways, has four cylinders, 16ins. diam. by 24ins. stroke, coupled wheels 6ft. 0ins. diam., total heating surface 2,727 sq. ft., and weighs loaded, without tender, 73 tons. The fire-box is of the water tube type, and the smoke-box contains the Drummond spark arrestor and fuel economiser.



New 4—6—0 Type 4-Cylinder Passenger Engine; London and South-Western Railway.

Bridges on the Bow to East Ham Widening; London, Tilbury and Southend Railway.—II.

By Chas. S. Lake.

In the course of the article (in the *Railway Engineer* for October) dealing with the general scheme of the Bow to East Ham widening works of the London, Tilbury and Southend R., it was stated that further and more detailed reference would be made in the present issue to the principal bridges on the route. Through the courtesy of Mr. Jas. R. Robertson, M.Inst.C.E., Chief Engineer, and his Resident Engineer, Mr. S. Heaton-Ellis, A.M.Inst.C.E., we are enabled now to fulfil this promise, and also to present detailed drawings showing the design and construction of the bridges referred to.

It will be remembered that the widened lines start at Campbell Road Junction, where the Whitechapel and Bow R. joins the London, Tilbury and Southend main line. At the time of the commencement of the widening the bridge carrying the line over

Fig. 1.—Bridge over Campbell Road. Removed when Bow to West Ham Widening was carried out.

Campbell Road was comprised of two outside main girders, supporting at a distance of some 10ft. from their respective abutments two heavy suspended girders (see fig. 1) fixed directly over the footpath kerb in the public street, and these in turn supported two smaller main girders, the latter being approximately parallel to those on the outside, thus dividing the bridge into three portions. This arrangement was necessitated by the restricted depth available, while no supports were allowed in the street below. The widening operations made it obligatory to remove nearly all this bridge as, with the exception of the outside girders, it could not be adapted to meet the new requirements.

In effecting the removal, the first thing done was to erect two trestles on each side of the suspended girders to support the short main girders in the middle portion of the bridge. The suspended girders were then cut away and lowered between the trestles to the footway, and from thence removed. Prior to this the new abutments on the north side of the railway (and which were to carry the new lines) had already been built, and as many bed stones as possible fixed in position. The portion of the old bridge on the north side, consisting of one long main girder and one short main girder with flooring between, had been prepared for removal previous to the night of October 1st, 1904 (the date selected for the re-construction of this portion of the bridge) and work commenced immediately after the passing of the last down train shortly before 1 a.m. Within a little over 10 hours from this time the operations had been carried to a successful conclusion and the new girders put in position with a temporary timber floor, and the new lines were then laid ready for traffic. The remaining portion of the old bridge was next removed and the new girders placed in position by October 16th, 1904, the permanent way being carried between girders as in the previous case with a temporary timber flooring. The work of building the jack arches was then proceeded with and completed in the ordinary course.

The widening is next carried over the North London Railway and Locomotive and Carriage Works at Bow, by a bridge having a clear opening varying from 135ft. on the south side to 150ft. on the north. It was decided that whilst this widening was being carried out the existing bowstring bridge carrying the London, Tilbury and Southend R. over the North London R. should be renewed, and a new bridge of 135ft. span was built. The removal of the old bridge and the placing in position of the new one was a matter attended by no small difficulty, and a short description of the manner in which it was accomplished will doubtless be of interest.

A heavy timber staging was built on the north side of the L.T. & S.R. old line, and upon this the new bridge was erected, complete with permanent way, the old bowstring bridge, which was constructed of two outside and one centre girder and a flooring of 12ins. × 12ins. timbers bolted to the underside of the bottom flanges, having in the meantime been gradually dismantled until only the flooring, supported by a strong timber staging, with steel beams acting as rail bearers, remained in position. The work of removing the permanent way, together with the timber flooring and longitudinal rail bearers, was commenced at 12.40 a.m. on Sunday morning, July 10th, 1904, and by 4 a.m. the necessary clearance had been effected. The new bridge, which is constructed wholly of steel, and on which the permanent way had already been laid, weighing together about 420 tons, was then traversed, some 30ft., on trolleys running on the abutments, into position, by means of hand winches and tackle. This operation was finished shortly after 6 a.m., and two hours later the bridge had been lowered by hydraulic jacks into its final position. By 10.30 a.m. on the same day the permanent way had been connected up, and at 11.20 a.m. (10h. 40m. after starting operations) the first passenger train passed over the new structure. The second bridge, viz., that for carrying the widened lines on the north side of the railway, was then proceeded with, the same staging as before being employed for the purposes of erection, the site in this case being the permanent one.

Each of the spans over the North London R. has two main girders, see figs. 2 to 4, of the open braced type, with curved top boom; 18 cross girders 9ft. apart, rail bearers and flooring. The main girders are 17ft. deep at the centre and 12ft. at the ends, the booms being of trough section with two webs, 1ft. 10in. in depth. The ties are attached to these by steel gussets and the struts are of ordinary girder section, viz., flanges, angles and web. The main girders are braced together by three overhead lattice cross girders with diagonal ties. Both the renewal and new bridges are supported at both ends on 9in. steel pins in cast iron knuckle bearings, and expansion and contraction is provided for at the west end by bronze sliding plates, details of which are given in fig. 7, these have been found to give very satisfactory results. The permanent way on the bridge is of the standard London, Tilbury and Southend R. type, and the road is on a

gradient of 1 in 90. Great attention was given in designing the bridge to render every part of it easily accessible for cleaning and painting. In order to provide easy access in the future to the underside of the floor for purposes of painting and general maintenance, rails have been fixed on the outside of the bottom booms on which a light suspended gantry can run, and so avoid the expense and trouble of fixing scaffolding on each occasion. The approximate weight of steel in each bridge is 400 tons.

Before reaching Bromley Station the railway passes over Devons Road by a bridge of ordinary construction with plate girders and trough flooring. This bridge was originally the property of the North London R., but had been taken over by the London, Tilbury and Southend R. Co. Owing to its light construction it was necessary to renew the superstructure, which operation was carried out in the course of a night.

The most important bridge on the route is that over the River Lea and Bow Creek. It has two spans measuring 194ft. 3in. from centre to centre of bearings; these being carried upon six cast-iron cylinders filled with concrete in the lower portions, and blue brick work in cement for the upper portion. The cylinders, of which two were placed on the shore on either side and two beside the tow-path in the centre, are sunk to a depth of from 18ft. to 24ft. below the bed of the river. The centre cylinders, which carry the ends of both spans, are 15ft. diam. at the bottom tapering to 7ft. 6in. diam. above ground level, whilst those on the shore ends of the bridge have a diameter of 9ft. at the bottom tapering to 6ft. at the top. The height from the bottom of the foundations to the top of the cylinders varies from 40ft. 6in. to 46ft. 6in. Below each of the cylinders there is an undercut concrete toe from 3ft. to 4ft. in depth, and projecting between 1ft. and 2ft. all round outside of the cylinder. The cylinders were sunk in the following manner:—A large square timbered hole was cut to a depth of 23ft. from ground level. The bottom sections of the cylinder were then placed in this and well weighted down through 12ft. of ballast on to the blue clay below, the ballast being excavated by divers. The cylinders were pumped out and further weight applied; the top layers of clay (which were freely impregnated with sand and moisture) being excavated until an approved bottom had been reached. None of the work was done under air pressure. The next step was the formation of the concrete toe already referred to at the base of each cylinder. This was done by cutting a circular hole 3ft. diam. and a 3ft. to 4ft. deep (according to depth of toe) in the centre of the space enclosed within the cylinder and filling the cavity thus formed with concrete, the remaining portion of the toe being put in in segments, each of which was filled in with concrete before further divisions had been excavated.

No difficulty was experienced in carrying out this part of the work, except at one point, viz., where the foundation of one of the new cylinders abutted on a cylinder supporting the existing bridge, which stands immediately alongside the new one on the north side of it. It was anticipated that trouble might be exp

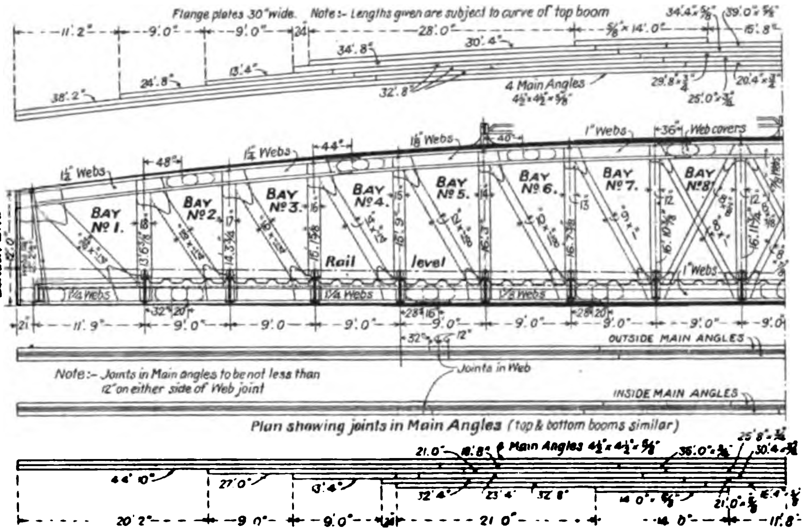


Fig 3.—Bridge over North London R. Half Elevation of North Girder.

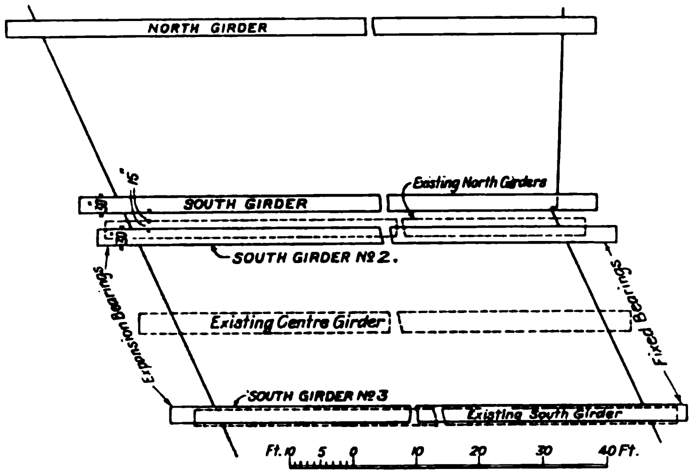


Fig. 2.—Bridge over N.L.R. Plan of Abutments.

NOTE.—The Camber, when the Bridge is erected and taken its permanent set, to be not less than 1¼in. or more than 1½in. All Girders and Flooring, &c., except where otherwise ordered, are to made of steel.

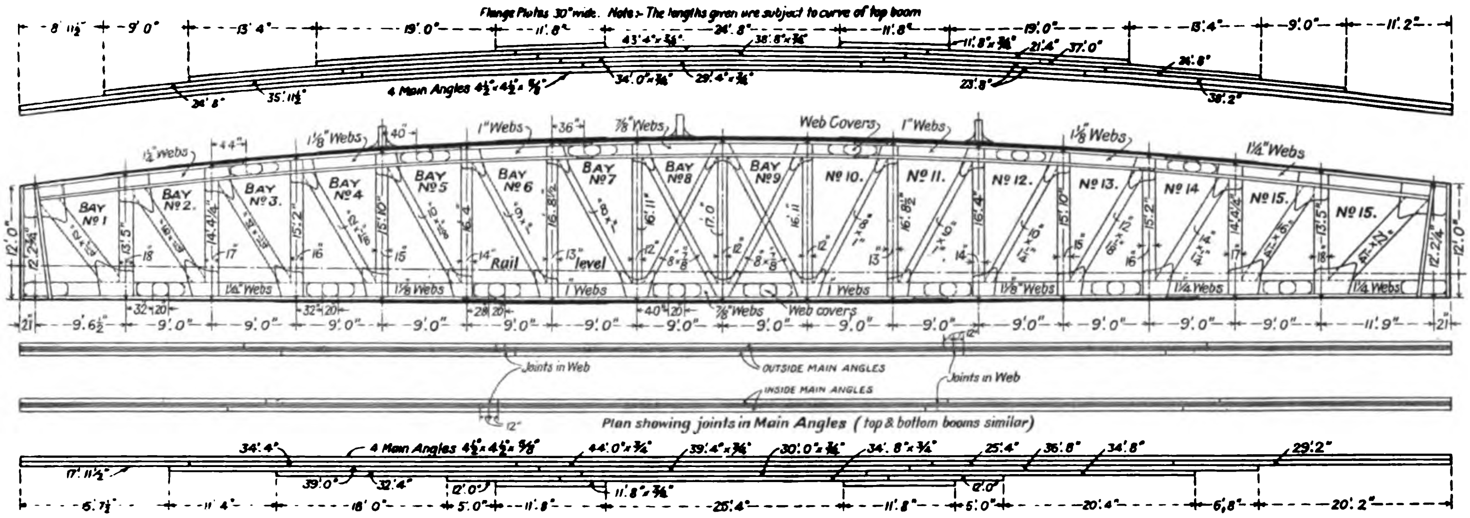


Fig. 4.—Bridge over North London R. Elevation of South Girder. Bow to East Ham Widening; L.T. & S.R.

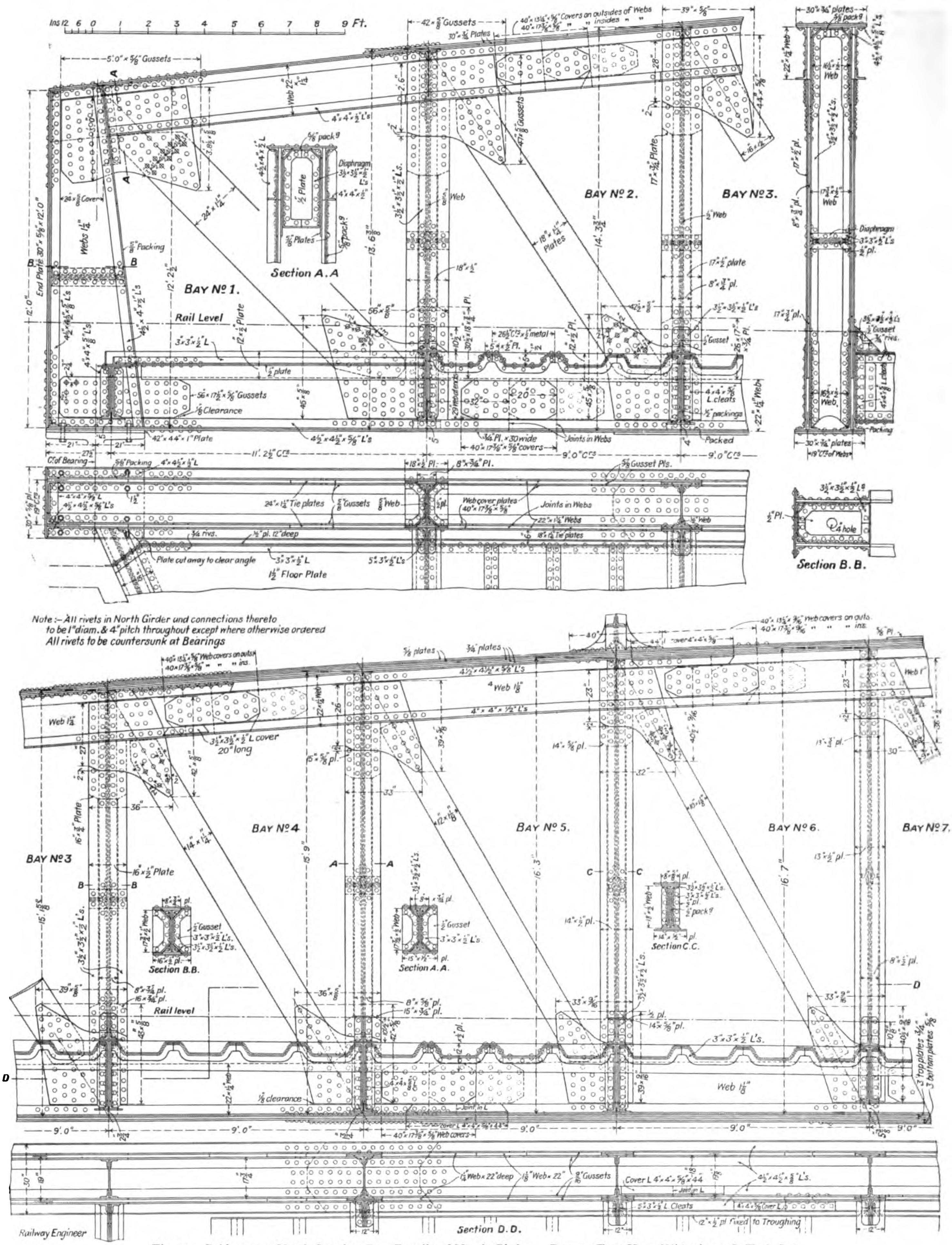


Fig. 5.—Bridge over North London R. Details of North Girder. Bow to East Ham Widening ; L.T. & S.R.

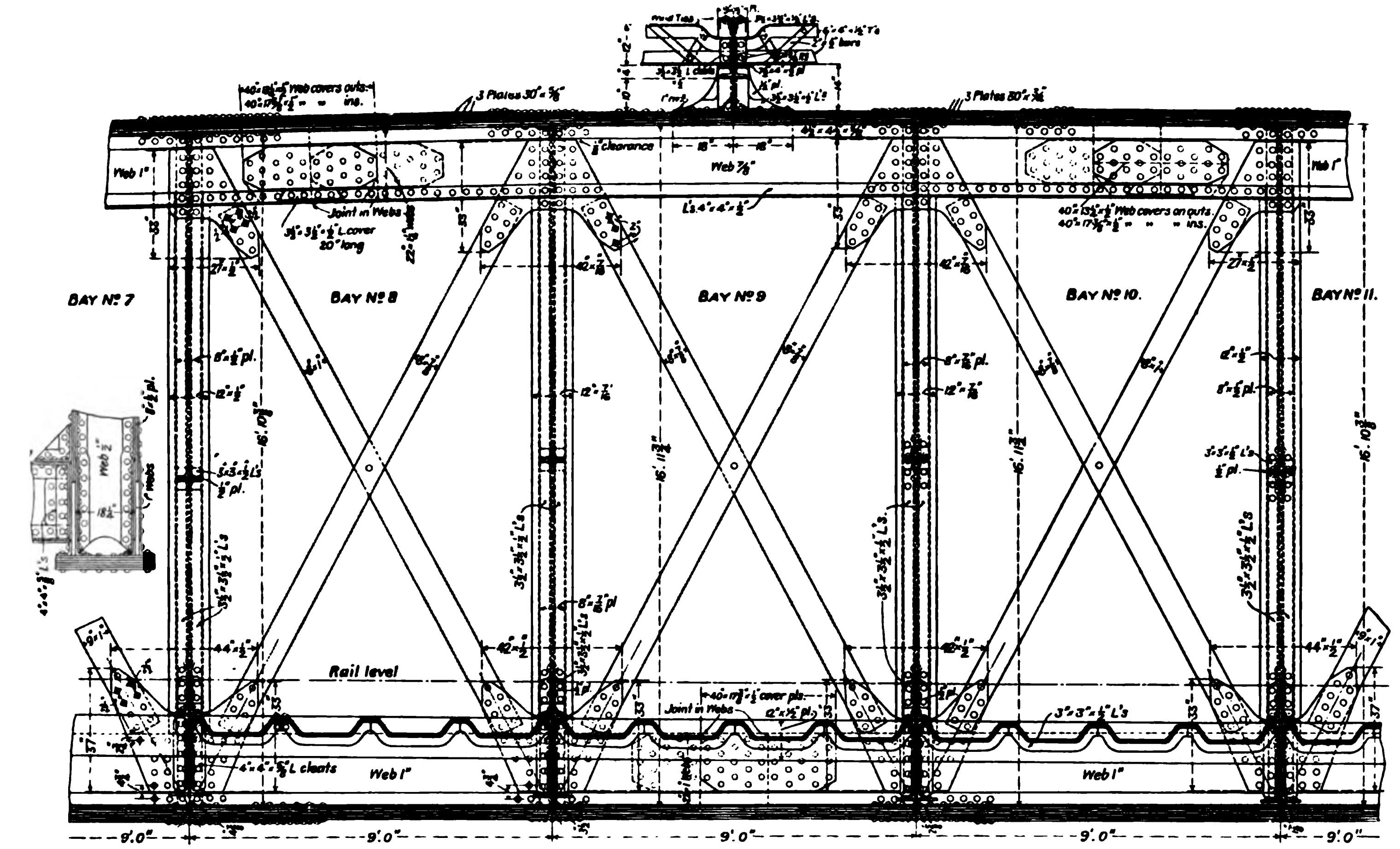


Fig. 6.—Bridge over North London Railway. Details of North Girder, Bow to East Ham Widening; L.T. & S.R.

rienced at this point from water breaking in during the excavation of the last segment of the toe for the new cylinder, and consequently this was provided against by having the concrete filling prepared and ready to drop into its place the moment the water made its appearance. The plan was carried out with great promptitude, and in this way any danger of flooding the cylinder was entirely avoided. On the completion of this portion of the work the cylinders were filled in with concrete to a height of 30ft. from the bottom, the remainder being filled with blue bricks set in cement.

Before proceeding with the superstructure all the cylinders were thoroughly tested, those in the centre under a load of 750 tons of steel rails (fig. 14), and those on the shore under a load of 380 tons. These weights were kept in position about a week—until the downward movement of the cylinders had ceased, which occurred after sinking from ½in. to 2½ins., these figures being the minimum and maximum of the movements registered.

The abutments between each of the two shore cylinders are built of concrete 4ft. 6ins. to 6ft. in thickness and stiffened up

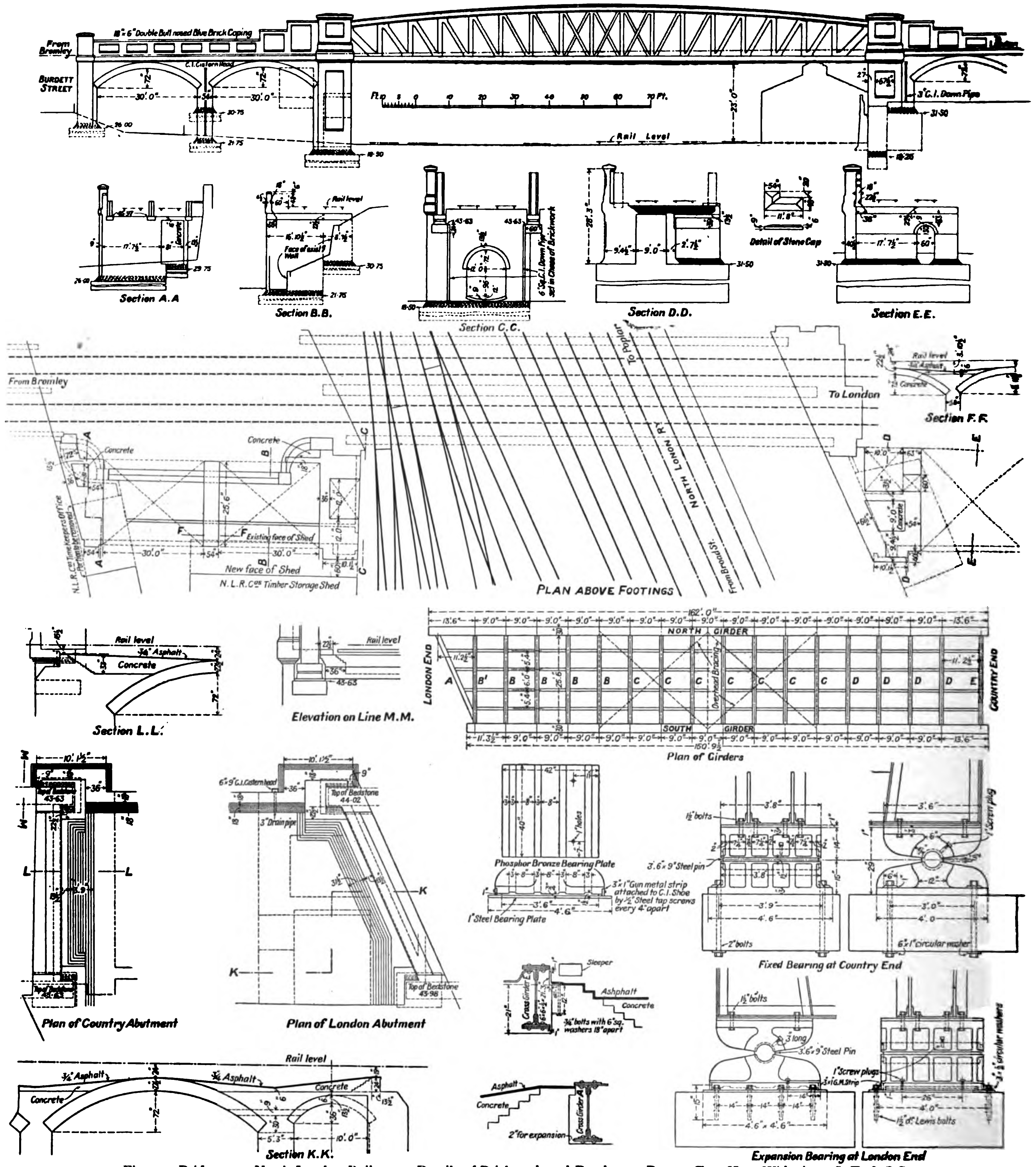


Fig. 7.—Bridge over North London Railway. Details of Brickwork and Bearings. Bow to East Ham Widening; L.T. & S.R.

with steel rails built together inside the concrete. They rest upon the top of the ballast, which is practically the bed of the river.

In erecting the super-structure, the four girders were built up on the Plaistow bank and piles were driven in the river Lea and in Bow Creek, leaving an opening for barge traffic of about 70ft. in both waterways. The girders were drawn over one at a time by means of a steam winch, and those intended for the south side were then traversed sideways to their final positions. Great difficulty was experienced after having traversed the River Lea girders, in lowering them on to their bearings owing to the extremely soft nature of the ground on which the temporary packings rested. It was, therefore, decided in the case of the Bow Creek span to drive piles against the

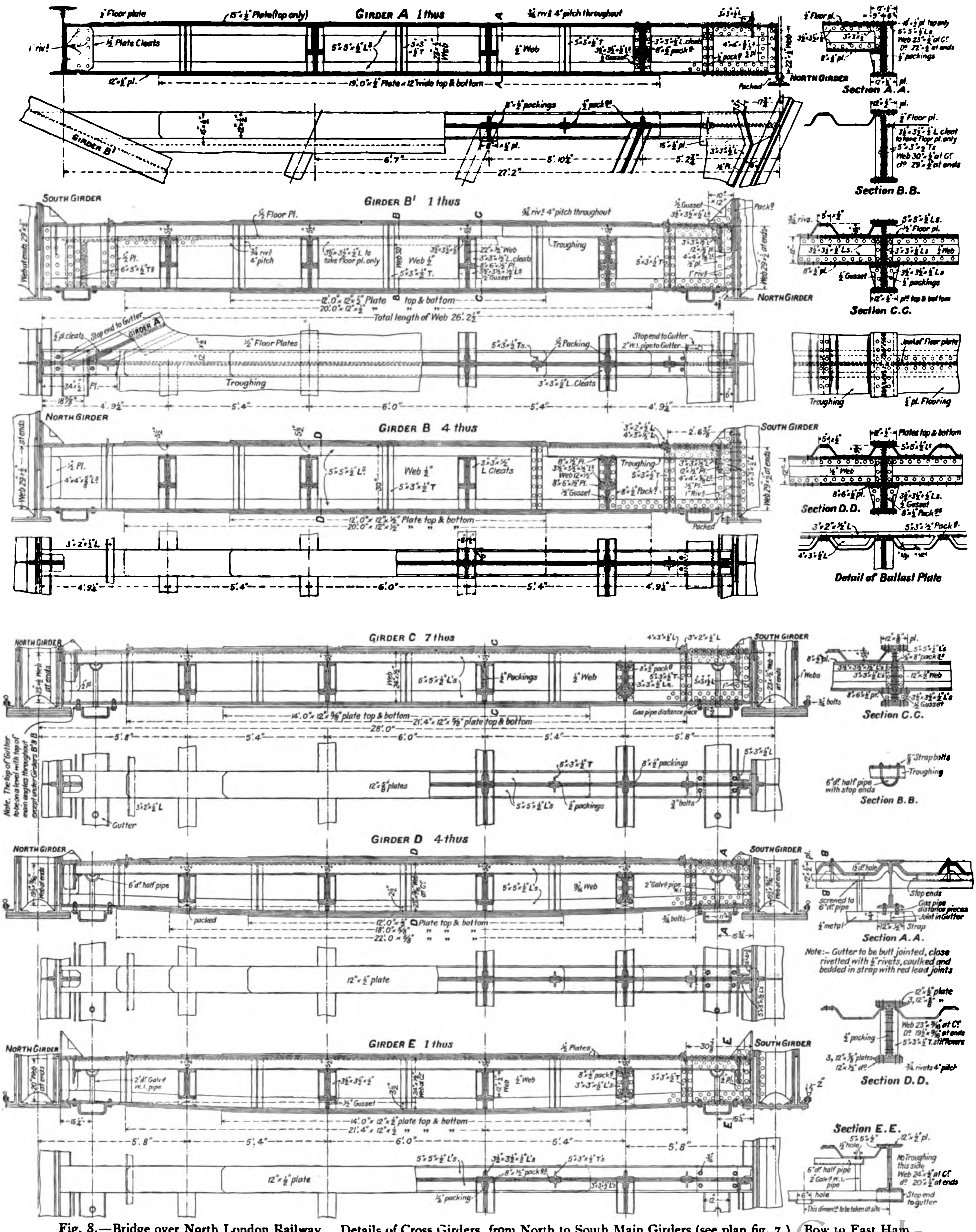
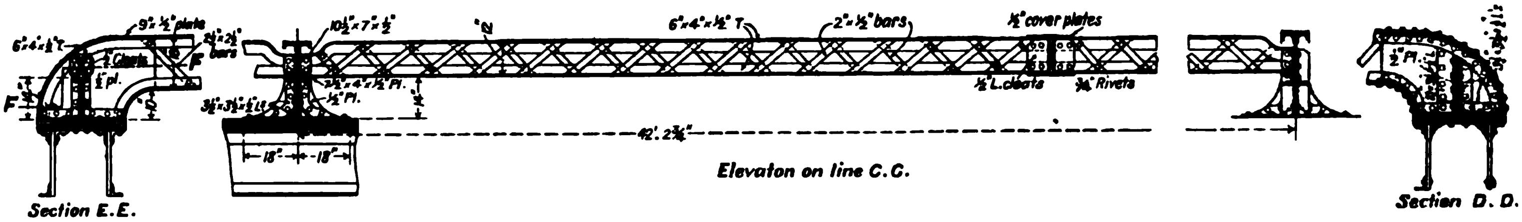


Fig. 8.—Bridge over North London Railway. Details of Cross Girders, from North to South Main Girders (see plan fig. 7.) Bow to East Ham Widening; L.T. & S.R.

cylinders on either side to a depth of 20 feet below ground level, and on these the southern girder was traversed, and both were then lowered to their bearings without difficulty.

The bridge (see figs. 6 and 7 Oct., 1905, issue) is constructed wholly of steel, the main girders being 16ft. 8ins. deep, with parallel booms of trough section 1ft. 10ins. deep, and webs 1¼in. thick throughout, with double system of open web bracing. The main girders are braced together by eight overhead lattice cross girders with diagonal ties and are supported at both ends upon 12ins. steel pins in cast iron knuckle bearings. Expansion and contraction is provided for at the shore ends by bronze sliding plates. Hobson's flooring, stiffened with steel channel ties and diaphragms,



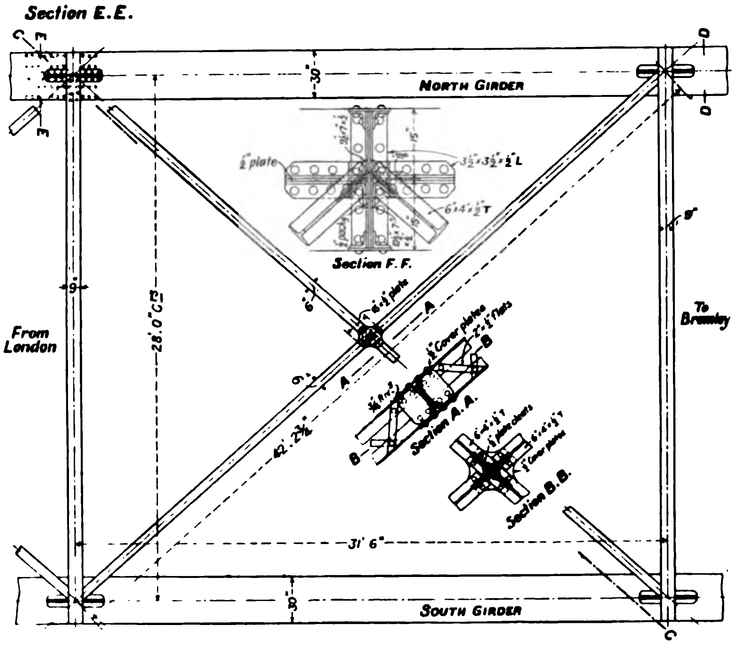


Fig. 9.—Details of Wind Bracing.

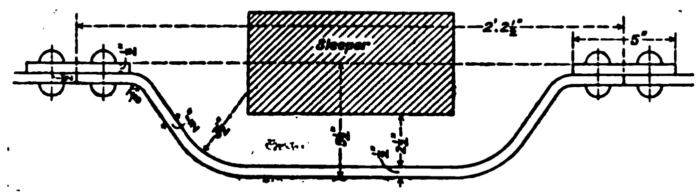


Fig. 10.—Section of Flooring.

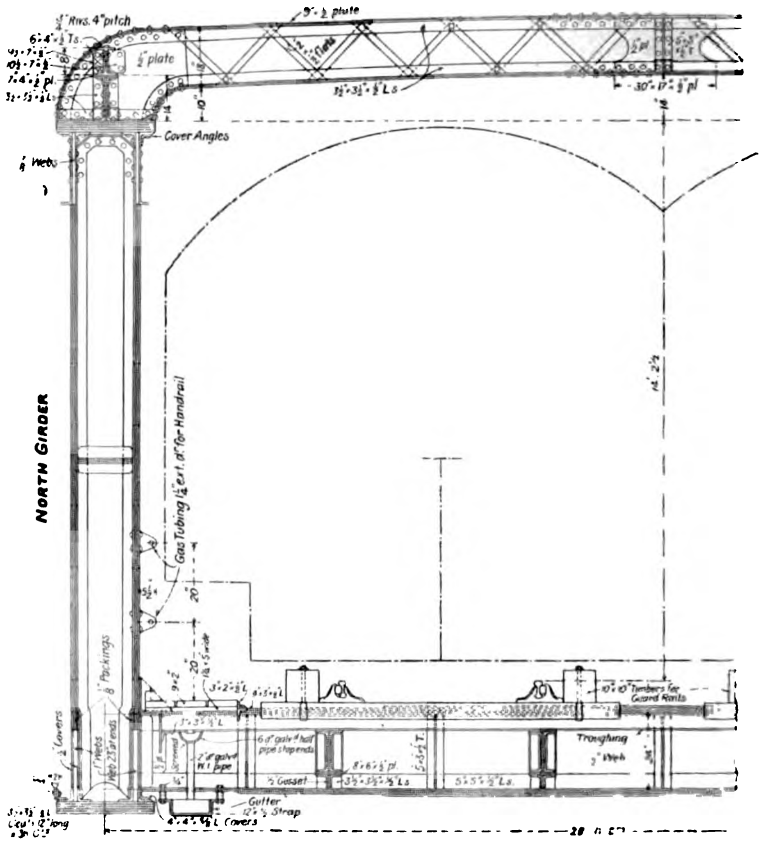


Fig. 11.—Part Cross Section at Centre.

Bridge over North London Railway. Bow to East Ham Widening ; L.T. & S.R.

has been used in this bridge. Coke breeze concrete in cement in a proportion of 4 to 1 has been used for filling in the haunches, and the whole brought to an even surface, and then coated with Seyssel asphalte, provision being made for carrying off the water at the sides. By this system of flooring a very large amount of dead load is saved, the continuity of the permanent way is unbroken and the even surface obtained enabled a junction for Bromley Goods Yard to be laid on the bridge. The total depth from the under side of flooring to rail level is 2ft. 7ins. The permanent way is of the L.T. and S. standard pattern. The total weight of steel used in the bridge is approximately 1,050 tons. The older bridge which stands close alongside the new structure is of very similar design, the chief difference being in the flooring, which consists of cross girders, rail bearers and floor-plates.

The new bridge is provided with rails for carrying a suspended running gantry for cleaning and painting, similar to that on the bridge over the North London R. above mentioned.

The widening next crosses a bridge over a sunk road 20ft. wide made for the Gas Light and Coke Co. This bridge is constructed of square section of steel trough flooring resting on brick abutments. The troughing is filled in with cement concrete and brought to a level surface, and coated with asphalte. The depth from underside of flooring to top of rails is 2ft. 6ins.

In future issues we shall publish drawings of the bridge under the public road at Pelley Road, the Occupation Bridge for the Gas Light and Coke Co. and the bridge over the River Lea.

At West Ham the widening crosses over the Woolwich branch of the Great Eastern R. and Manor Road by six spans, three on the north and three on the south of the existing bridge. These are all constructed of ordinary plate girders and trough flooring (in which are embedded the sleepers), supported on brick piers and abutments.

Between West Ham and East Ham the widening passes under seven bridges, mostly of a similar construction, viz., longitudinal girders about 9ft. deep, jack-arches supported by brick abutments on either side, with a steel trestle in the centre of the railway, the spans being from 25 to 30 feet. Provision has been

Fig. 12.—Looking down one of the Cast Iron Cylinders 30 feet deep. Bridge over River Lea.

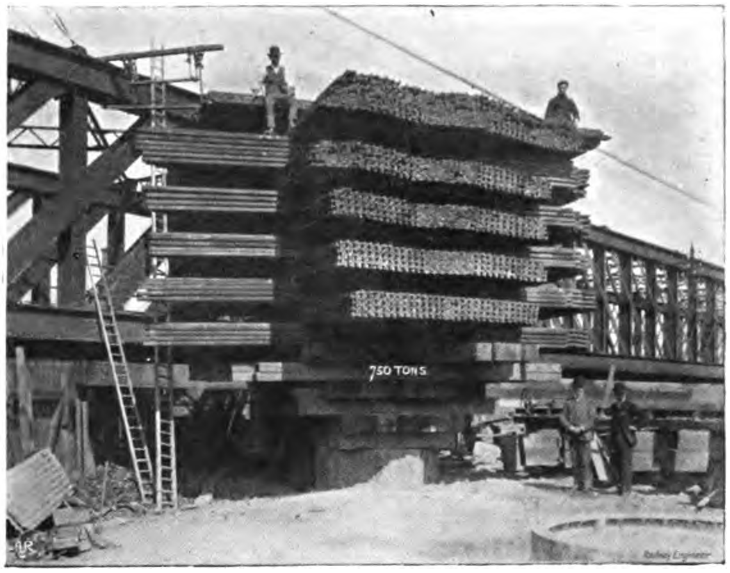


Fig. 14.—Testing Cast Iron Cylinder under a load of 750 tons. Bridge over River Lea.

made for carrying pipes and mains in the two outside bays of each bridge, by substituting a flat steel plate in place of the brick jack-arch.

The contractors who successfully carried out Mr. Robertson's plans and designs were :—For the whole brickwork and steelwork for the bridges between West Ham and East Ham, Messrs. J. Mowlem and Co., of Westminster ; for the cylinders and abutments of the River Lea, Messrs. T. Docwra and Sons, Balls Bond, N. ; for the bridges over the North London R. and Devons Road, Messrs. Head, Wrightson and Co., Stockton-on-

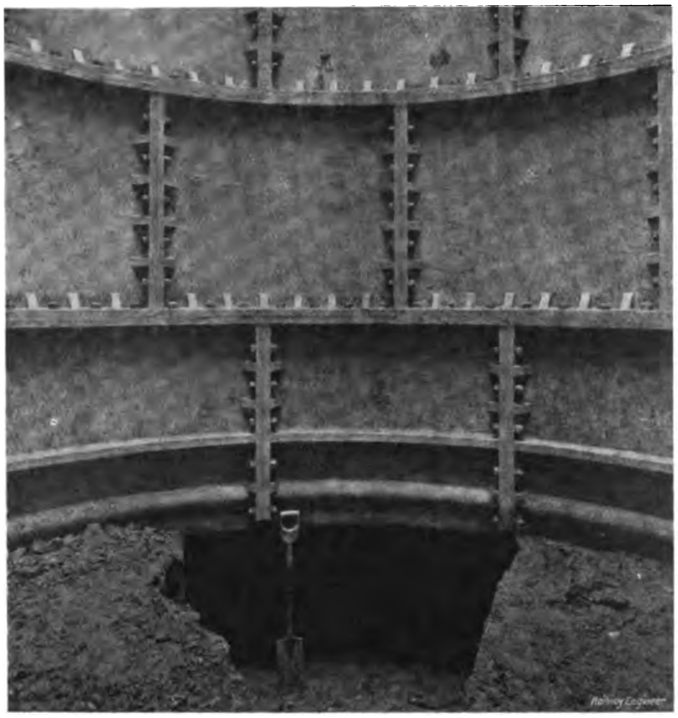


Fig. 13.—Undercutting a Cast Iron Cylinder 30 feet deep for the concrete foundations. Bridge over River Lea.

Tees ; for the River Lea bridge, Messrs. Arrols Bridge and Root Co., Glasgow ; and for the remainder of the steelwork, Messrs. The Horseley Co , Tipton, Staffs.

To Mr. H. W. Stride, A.M.I.C.E., credit is due for the way he supervised and carried out the general work in his capacity of District Engineer and for the manner in which he solved the intricate problems connected with the many alterations and diversions of the permanent way which had to be made without causing any interference with the regularity of the traffic on the line. Mr. S. Heaton-Ellis, A.M.I.C.E., who acted as Resident Engineer on the principal part of the widenings, and under whose charge most of the bridges described were erected, is also to be congratulated on the result of his labours and the well-finished appearance of the works.

In conclusion, the writer desired to express his thanks to Mr. James R. Robertson, M. Inst.C.E., for the facilities to view the bridges and also for the use of drawings accompanying this article, also to Mr. S. Heaton-Ellis for explaining the details of the bridges on the site of their erection.

Four-Cylinder Compound Locomotive, with Superheater ; Belgian State Railways.

By Charles R. King.

One of the three entirely new four-cylinder locomotives built this year for the State Railways of Belgian is shown in the accompanying illustrations. It is known as Class 19A, and is intended for hauling the heaviest express trains upon lines of steep gradients, and for this reason the wheels are only 70$\frac{7}{8}$ins. diam. It is designed to pull a train of 350 tons at 62 miles per hour on the level. Eight engines are to be built of this type, and the design will be further repeated in identical engines, but having wheels of the standard size for the fastest trains of the Belgian State Railways, that is, 78ins.

The locomotive illustrated has the double-action Cockerill superheater for compound engines, but the second and third engines will, for purposes of experiment, be fitted with the

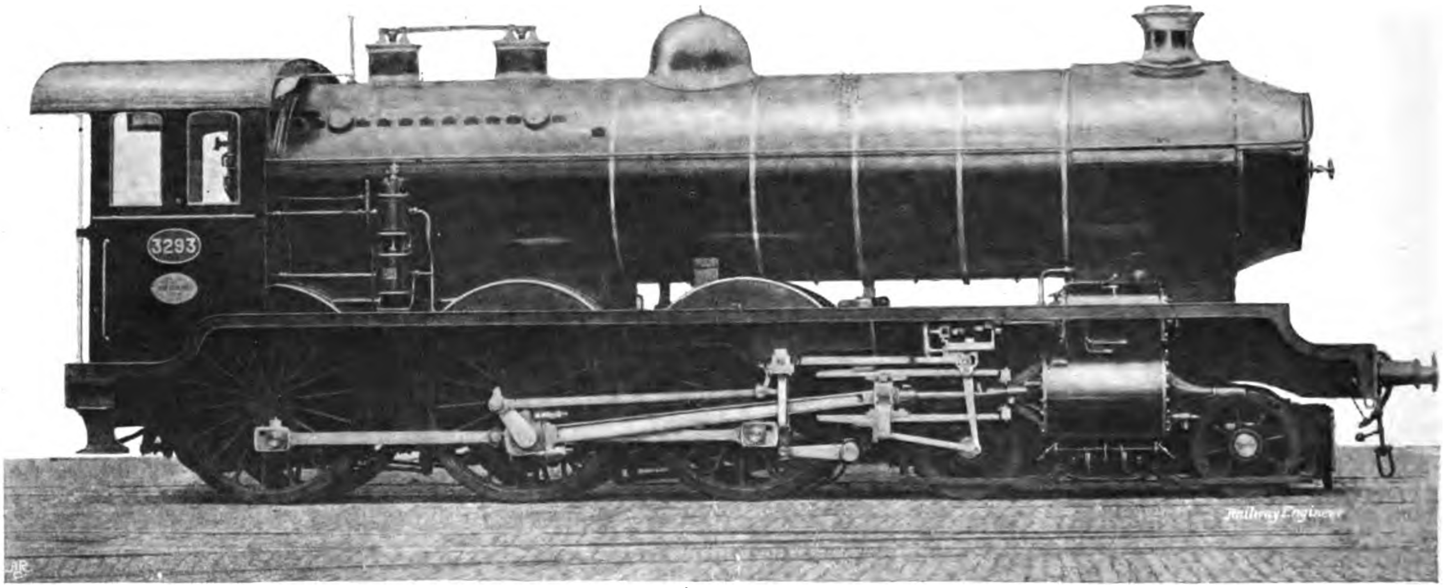
Cockerill single-action or receiver-superheaters, which are fitted to another engine series, Class 19.

The locomotive under notice, although following Central European practice in having the low-pressure cylinders outside the frames, and only two sets of valve-gears, is really on the Paris, Lyon and Mediterranean balanced compound system, as designed in 1888 by Chief Engineers Henry and Baudry.

The inside cylinders are advanced about half their length ahead of the outside pair to allow the inside connecting rods to work on to the first coupled (cranked) axle, and consequently the union of the two sets of cylinders is a strong one, and neither the outside cylinders nor the saddle casting connecting them trans versely present any impediment to easy inspection of the inside cross heads and piston rod packings, as is the case in some other arrangements in which the inside cylinders are much more advanced; moreover, there are no inside frame stays, as they are not needed in this form of construction (see plan). The accessibility of the engine, for inspection or repairs, is therefore practically the same as in the Central European designs.

voluminous with the object of preventing excessive compression, for superheated steam has the reputation of being very inelastic and of causing heavy wear in bearings, axle boxes, &c. Small clearance volumes can be easily arranged with piston valves, even where there is only one valve chest for two cylinders; but practice shows that for high-speed locomotive engines a large clearance volume is necessary for free steaming; and the old term, *espace nuisible*, in French, is now being replaced by the Italian *espace mort*, and, better still, by *espace neutre*; for, so far from being detrimental in locomotives, large clearance spaces are a real necessity.

The valves are operated by the Walschaerts' gear. It is not without interest to note that this gear was invented by Egide Walschaerts, a Belgian mechanical genius, and patented on October 5th, 1844, when the Sharp gear was in general use, and before the Howe or Stephenson gear had been much used. The same gear was patented by Waldegg von Hensinger in 1849, or a year later than Walschaerts' improved mechanism, which is practically the same to this day. Since that time the Walschaerts'



Four-Cylinder Compound Locomotive, with Superheater. Belgian State Railway.

It is interesting to notice that the P.L. and M. locomotives have their cylinders cast in three pieces, viz., the low-pressure cylinders, inside, forming one piece, and the two smaller cylinders, outside, bolted to the frames, while in the Belgian engines the cylinders are cast in two pieces, each consisting ot one l.p. cylinder (outside) and one h.p. cylinder. With the large cylinders outside the frames this method gives immunity against working loose, particularly when superheated steam is used.

The l.p. cylinders drive upon the second coupled axle.

The crank axle is of the ordinary pattern with parallel webs, but as it carries no inside eccentrics there is ample room available for very strong and thick crank webs.

Central admission piston valves are fitted to all the cylinders, so that the superheated steam does not come into contact with the external surfaces, and no metallic packing is needed either back or front for the valve spindle glands, which are, instead, simply bronze sleeves with helical oil grooves turned in them. The segments are of cast iron, three in number, and steam is admitted behind the principal segment as in the old Ricour piston valve. Specially-large clearance spaces are allowed for the h.p. cylinders, the ports and steam passages being made unusually

gear has gradually displaced all others on express engines everywhere on the Continent, except in Belgium, where it has been but little used except, perhaps, for goods engine of old types.

But its adoption for modern compound engines in place of the Stephenson valve motion, so much employed since the importation of the Scotch locomotive designed by Mr. J. F. McIntosh, of the Caledonian R., is accompanied by certain novel features.

In order to give inside admission to piston valves of ordinary single-headed type the direction of the valves had to be reversed, this being effected as in the French locomotives of the *Est* and and P. L. and M. railways, by keying the valve crank in a position diametrically opposite to the normal arrangement for slide valves, and then pinning the radius-bar of the expansion link to the top of the lead-lever (universally known as the "advance-lever") in place of the valve spindle, which, in this case, takes the position on the lead-lever vacated by the radius-rod. This settles the question for the outside cylinders, but the inside valves also have to be reversed, for the ordinary vertical rocking-lever employed for transmitting the motion would not effect this re-reversal of direction. Therefore, to obtain the desired direction of travel for the inside

valves without employing double-ended piston valves, and without employing the peculiar rocking links which form such a striking feature in the transmission gear of the Bohemian-built locomotives illustrated in the *Railway Engineer*, April, 1905, issue, resort was made to horizontal rocking levers. The details have required a precision of adjustment admirable to mechanical engineers.

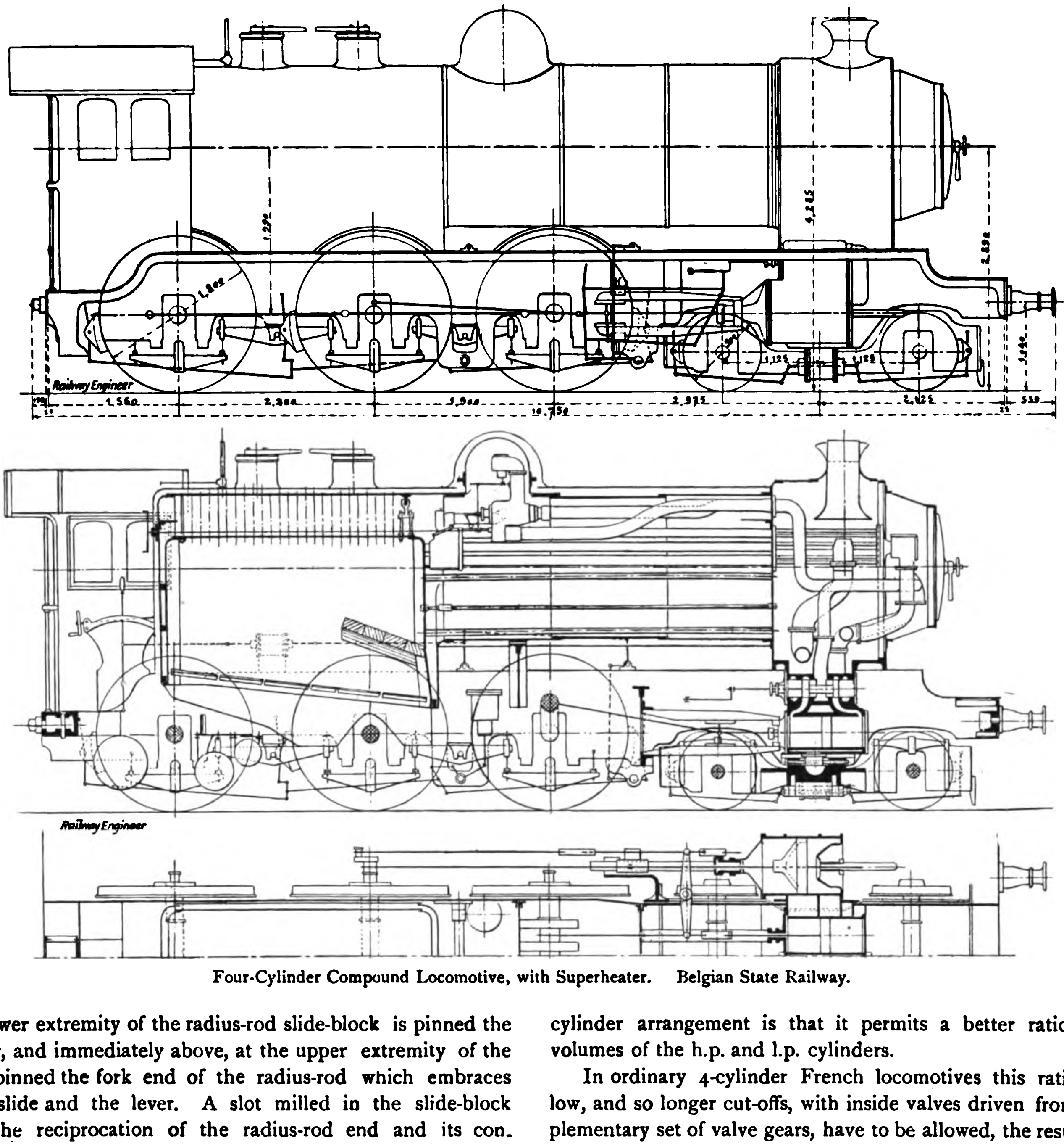
The arrangement is illustrated by a photograph and diagrams, but a few general remarks are necessary.

Bolted to the side of the frame is a massive cast-steel bracket, serving the double purpose of valve-spindle guide on its upper surface and lead (or advance) lever guide on its lower surface.

arising between the positions of each pair of valves, the work put into the mechanism is of the very best, and the massive fulcrum pin and bracket and the length of all the wearing surfaces are altogether excellent in design and are duly calculated for the *brusque* action of superheated steam.

As it is the smaller or h.p. valves which have to be driven by the transmission gear it is evident that the arrangement here adopted in grouping the cylinders lessens the work to be performed by the rocking-levers and connections. The advantage due to placing the high-pressure cylinders inside the frames is further increased when superheated steam is used.

Another important point in favour of the Central European



Four-Cylinder Compound Locomotive, with Superheater. Belgian State Railway.

At the lower extremity of the radius-rod slide-block is pinned the lead-lever, and immediately above, at the upper extremity of the lever, is pinned the fork end of the radius-rod which embraces both the slide and the lever. A slot milled in the slide-block permits the reciprocation of the radius-rod end and its connections. The upper and lower slides move together as one piece by means of a rigid tie between them, while they are also connected by short links working on the upper and lower ends of the rock-lever pin. At the opposite extremity of the rock-lever there is a similar connection by links to the inside valve-spindle slide also guided by a fixed bracket.

As there are five joints liable to wear and to a resulting slackness

cylinder arrangement is that it permits a better ratio for the volumes of the h.p. and l.p. cylinders.

In ordinary 4-cylinder French locomotives this ratio is too low, and so longer cut-offs, with inside valves driven from a supplementary set of valve gears, have to be allowed, the result being an engine working with greater internal resistance, while by reason of the limits now imposed on the inside low-pressure cylinders their further development in cylinder power is restricted.

The proper ratio for cylinder volumes, long ago recommended by Goelsdorf for four-cylinder compounds, is 1 to 3, and the Belgian engineers have come very close up to this ratio with 1 to 2·91 in the engine (Class 19A) illustrated. In consequence

it has not been necessary to resort to the expedient, common in engines having insufficient ratio of volume for the low-pressure cylinders, of greatly increasing the fixed percentage of valve travel for the latter cylinders. With the ratio of 1 to 2·91 the steam admission arranged for both cylinders is practically simultaneous, there being only a small constant lead of 2 to 3 per cent. for the l.p. cylinders.

Another point often urged by Goelsdorf was the possibility of very long admissions in starting—up to, in fact, 90 per cent. of the stroke. Among the locomotives shown at Liège were two notable examples which accord with this recommendation. First, in the P. L. and M. prototype of the Belgian locomotive, giving up to 88 per cent. admission to the h.p. cylinders and a constant and *invariable* admission of 63 per cent. for l.p. cylinders, and then, in the engine Class 19A, giving up to 90 per cent. admission for the high-pressure cylinders—when the link-block reaches the extremity of the expansion-link.

The reason for such long admissions is obviously the same as that given by Goelsdorf—that is, to suppress starting or intercepting valves, which the writer believes to have been the fundamental cause for the failure of the two-cylinder compound system in England some years ago. In introducing into Belgium the compound system with superheated steam on a scale of considerable magnitude, Belgian engineers have very studiously avoided this troublesome adjunct of the locomotive engine, and have thereby followed Central European practice. Consequently the locomotive never works as a single expansion engine, which change of working is, throughout the Continent, save in France, considered very undesirable.

With this long admission for getting under way it is only necessary to provide for the accident of cranks presenting themselves in unfavourable positions for prompt starting. This is done by supplementary admission of live steam to the low-pressure valve chests.

In the latest P.L. and M. engines this admission is effected by the manual opening of a small cock—a very old and simple arrangement—but it is far more usual to make this action entirely automatic and dependent either upon the maximum opening given to the regulator or upon the maximum valve-travel given through the valve gear, so that the driver has no more concern at starting than with two cylinder single expansion engines. There are a large number of simple devices now in use for effecting this automatic supplementary admission of steam. In the engine illustrated there is a small valve with differential pistons located in the smoke box, and which allows high pressure steam to leak into the low pressure valve chests so long as the pressure therein does not attain 88·2lbs. per sq. in. when starting. This regulation of the receiver-pressure is a very nice one, and is not dependent upon the receiver relief-valve for the control of excess pressure. The operation of this automatic valve can be stayed at any time by means of a small lever under the driver's hand.

As with all piston-valve engines, all the cylinder covers at each end are fitted with relief-pressure valves (visible in the photographic view), and air-suction valves are provided on the steam pipes to the high pressure cylinders and on the receiver.

The somewhat peculiar appearance of the cylinder ends will be explained on reference to the plan. The deeply-coned back end of the cylinder is intended to support the great length of the piston-rod, and which length was necessary in order to keep down the length of the outside connecting rods within the limit of 3 meters' length. The pistons of the low pressure cylinders had also to be cast with the same convexity for their rear faces and a corresponding concavity had to be given to the front cylinder covers. The front ends of the pistons are extended through the front covers and work in cast-iron sleeves, these latter being partly concealed by the conical casings of sheet steel shown in the illustration.

Engines of the category exemplified by the new P.L. and M. locomotives and by the Class 19A of the Belgian State Railways, although they embody the principle introduced by Webb of dividing the motor stresses, are not so simple to design or to construct, nor have the almost perfect balance of the Central European tyres (Class 19 and "La Meuse" engines). For instance, with the long piston rods and connecting rods a difficulty arises (especially where the wheels are of large diameter) of supporting the end of the guide bar or bars, and to carry which, in the absence of the usual vertical motion-brackets, it becomes necessary to build up a portion of outside frame over the leading driving wheels to support the tail ends of the guide bars as in the P.L. and M. engines. In the case of the engine Class 19A (wheels of 70⅞ins. diam.) it has been possible to support the guide bars at about mid-stroke of the crosshead without resort to an outrigging frame. In the plan given a motion bracket is shown bent backwards and covering up the front of the leading driving-wheels, but this detail appears to be a draughtsman's slip, since that arrangement belongs to a projected engine (which might be classed 19B) and in which the wheels are to be of 78ins. diam. In the locomotive of 19A illustrated an outrigging frame not dissimilar to that of the P.L. and M. is provided, but only for the support for the link motion in place of the valve-motion bracket between the two first wheels common in many well-known types.

Yet another advantage denied to all engines of this type having two driving axles is that the connecting-rods must be placed on the wheel pins *outside* of the coupling-rods, consequently the engines exert more disturbing force, resulting in side-lash, than do the engines of the Central European type having the connecting rod big ends seated on the crank-pins close up to the wheel boss. The sole superiority claimed for double driving axles, in any of the modifications made since Mr. Webb introduced this system, is the greater durability of the crank axles. But since that period the form of crank axles has been greatly strengthened, and we now have the example before us (in one of the new four cylinder simple engines of the Belgian State Railways) of all rods driving upon the cranked axle of an engine which exerts the enormous calculated effort of over 37,000lbs. by the formulœ $2 \times p \; d^2 \; l \div D$, and in taking p at only 14 atmospheres, although the boiler is constructed for the same pressure as the other new engines, *i.e.*, 228lbs. If this single driving axle has a working life of not much less than those of the P.L. and M. or de Glehn designs (with divided stresses) then the superior results accruing from a completely balanced pair of driving wheels (in which the wear of the axle boxes is reduced to a minimum) will be sufficient to demonstrate the all-round advantages of the Central European type. These tests of engine systems are being carried out in the most liberal spirit and scientific manner by the State Railways of Belgium, to whom all credit will be due for such a valuable contribution to our knowledge of economical locomotive design.

The engine having the fewest moving parts should run, all other things being equal, with the least internal friction, the gain so realised being expended in extra pull on the draw bar for increased loads or increased speed. It is all too common to see it written that the French compounds are the best engines for high

speeds—but this is merely an indication of faulty knowledge. Much higher speeds are often realised in Central Europe while testing engines, but they are little heard of because the poor and light roads in countries outside of France, or the ruling conditions opposed to long runs at high speeds, do not permit the regular continuance of such work, but if Central European types could be run on first class tracks there can be no doubt whatever that unprecedented speeds would then be attained.

One Central European type has run at 90 miles per hour with a gross load of 250 tons upon a slightly rising gradient, and, with the same train, on gradients (of up to 1 in 240) rising continuously for a distance of 69 miles, has made average start-to-stop speeds of 73 miles per hour.

The Belgian four-cylinder engines, even with wheels of 78in. diam., are not intended for very high speeds or long runs, which would be uneconomical in a densely populated country such as Belgium. But great boiler power is provided. The working pressure is 227·8lbs. and the boiler diameter is 5ft. 4½ins.

All boilers are now of Caledonian pattern, except for the great reduction which it has been found necessary to make in the depth of the firebox, together with the provision of a shorter brick arch. In general details it will be noted that the boiler is fitted with two sets of the Klotz-Wilson safety valves, now for many years used with Belgian locomotives. The reversing gear is worked by steam, the operation of moving the quadrant lever admitting steam to either side of the servo-motor by the simple connection of this lever with a three-way cock. The usual reversing screw and wheel are also provided, if, for any reason, it was desirable to reverse the engine manually, or to adjust the degree of admission between any two of the gradient notches. This power-gear is applied to nearly all the engines exhibited, and a very ingenious, but less simple, arrangement exists for Belgian engines having two sets of valve mechanisms—as notably those of the de Glehn type.

The bogie-truck is of a new standard tpye designed for all four-cylinder engines, including even the de Glehn "Atlantic" engines, it being of the swing cradle type, without any lateral swing-control springs and having an independent riding spring for each wheel. The links by which the cradle is swung upon the bogie frame are so short and incline at such a sharp angle that the return to centre is effected rapidly by force of gravity alone. The pivot is a hemispherical bearing stepped in a cup seating on the cradle. A safety pin passes in a longitudinal direction through the pivot, to prevent it unseating from any cause or in any place. The side play allowed on each side is 2¼in. The rail guards are attached to the bogie frame instead of to the engine frame. To steady the front end of the engine vertically-placed helical springs are contained in two side rests—one on each side of the bogie frame. Within the limits imposed by these flexible side bearings the bogie frame, besides turning radially, has a universal movement about its pivot, while the engine main frame is free to ride laterally, the engine always being tilted to the inside when traversing short radius curves by reason of the shortening or lengthening of the cradle links in a vertical direction.

Although great satisfaction is expressed with the boilers of Scotch type it is generally known that the riding gear of those locomotives was not adapted for Belgian tracks, and the result of this nine years' experience is that in the whole of the new four-cylinder engines all their driving wheels springs are inter-connected with compensating levers, as was customary before the advent of the Caledonian types.

Every wheel of the engine is power-braked, the bogie wheels having, as usual for all Belgian bogie engines, direct acting air brake cylinders between the wheels. Originally, braking of the bogie wheels in Central Europe appears to have been due to the relatively small loads carried by the driving wheels, but this is not the case with the Belgian engines, which, with their load of 18 tons per axle, exceed the wheel weights of all Continental locomotives, this being permitted by the heavy section "Goliath" rails of the Belgian State Railways.

The engine illustrated was built at Seraing by the Societé Anoyme John Cockerill, to whose courtesy the writer is indebted for facilities of visit during its construction at those works.

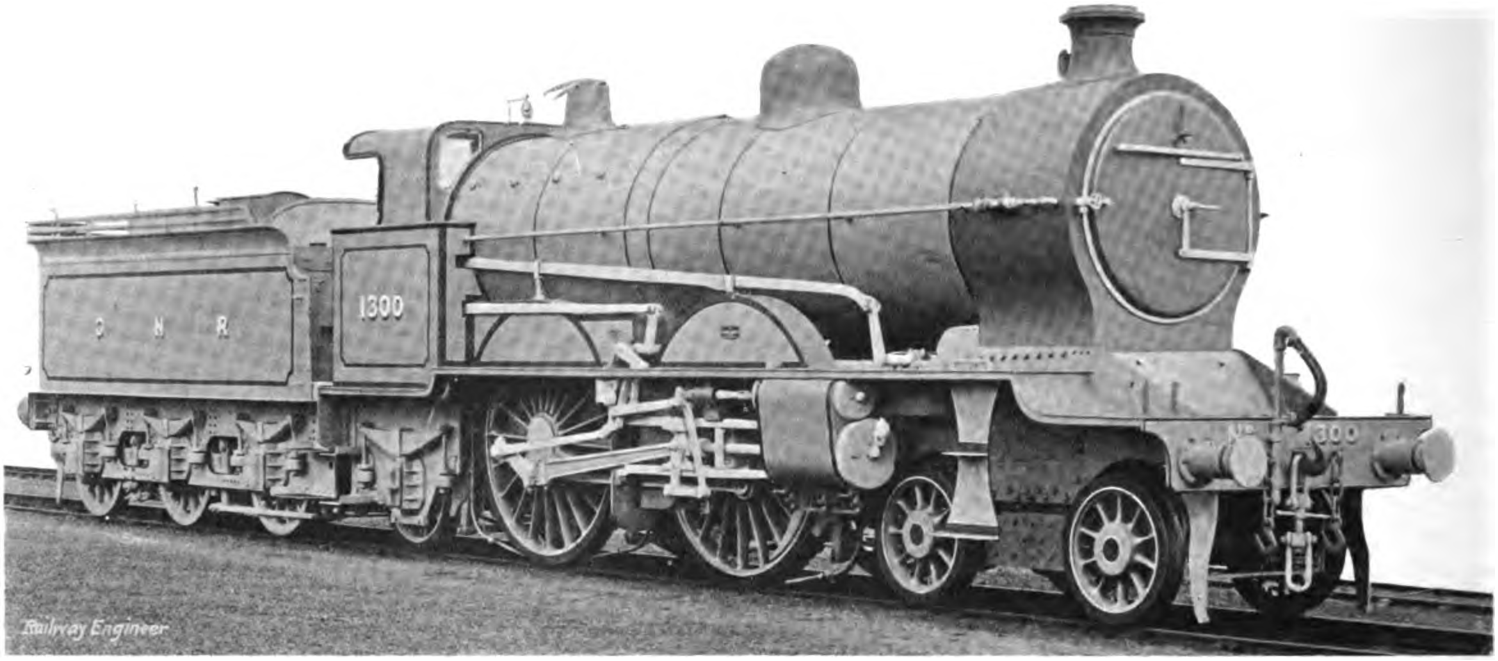
Cylinders (d)	High pressure	$14\frac{3}{16}$ins.
(d^1)	Low pressure	24½ins.
(l)	Piston stroke	26¾ins.
(p)	Boiler working pressure	227·8lbs.
(D)	Driving wheels diam.	70⅞in.
	Tractive effort (theoretical) $1.5\ p\ d^2 l \div D$	25,740lbs.
	Adhesion weight	54 tons.
Water-heating surfaces—	Firebox	197·5 sq. ft.
	Tubes	1696 „
	Total	1893·5 „
Steam-heating surfaces	... ...	446·5 sq. ft.
Grate area	... ...	32·4 sq. ft.
Engine weights—	Empty	68 m. tons.
„ „	Fully loaded	74 „

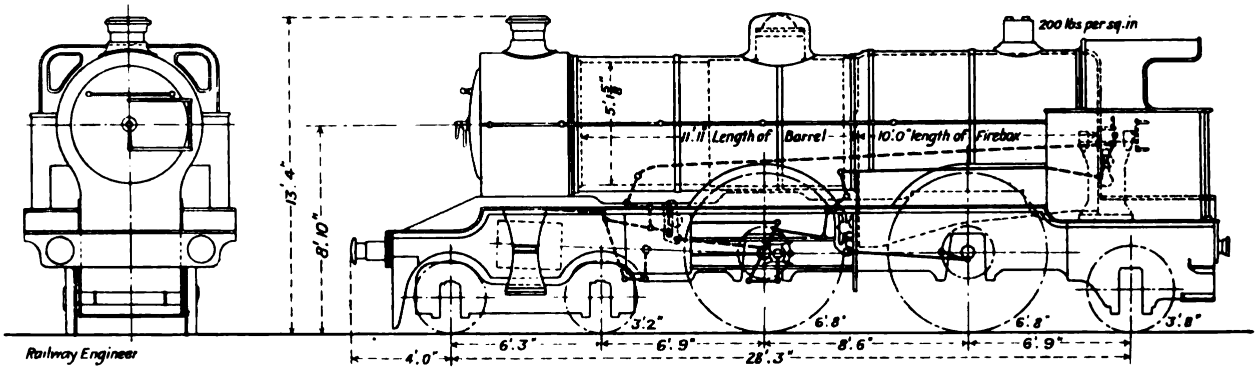
4-Cylinder Balanced Compound Locomotive; Great Northern Railway.

We are indebted to Mr. H. A. Ivatt, M.Inst.C.E., chief locomotive engineer of the Great Northern Railway, for the accompanying photograph and particulars of the four-cylinder compound locomotive No. 1300, which was designed and built by the Vulcan Foundry Co., Ltd., of Newton-le-Willows, upon the basis of particulars (as to loads, gradients, etc.) supplied by the locomotive engineer. The Directors of the Great Northern Railway—in consultation with Mr. Ivatt—being desirous of testing the capabilities, under the conditions of service met with on their railway, of the best locomotive to be obtained from English firms, accepted the designs submitted by the Vulcan Foundry Co., Ltd., and ordered an engine to be built to them, and which has recently been delivered. The engine is undergoing fair and very thorough trials, the results of which will no doubt be made known at a later stage, to which time criticism of the design may be conveniently postponed.

The locomotive is fitted with the Vulcan patent starting valve for admitting steam into the L.P. cylinders at a reduced pressure, when additional power is required, and also has the Vulcan patent screw reversing gear, allowing of the cut-off in the cylinders being independently varied. The principal dimensions are as follows :—

Cylinders h.p.	14in. diam.
„ l.p.	23in. „
Piston stroke	26in.
Coupled wheels	6ft. 8in. diam.
Rigid wheelbase	8ft. 6in.
Total wheelbase	28ft. 3in.
Boiler outside diam.	5ft. 1⅝in.
Length of barrel	11ft. 11in.
Height of centre from rail	8ft. 10in.
Number of tubes (serve)	149
Diameter of tubes	2¾in. outside diam.
Total heating surface	2,514 sq. ft.
Grate area	31 sq. ft.
Working pressure	200lbs. per sq. in.





Four Cylinder Balanced Compound Locomotive; Great Northern Railway.

The weight of the engine loaded is 71 tons, distributed thus: On bogie wheels 20¼ tons, on coupled wheels 37 tons, trailing wheels 13 tons 15 cwt.

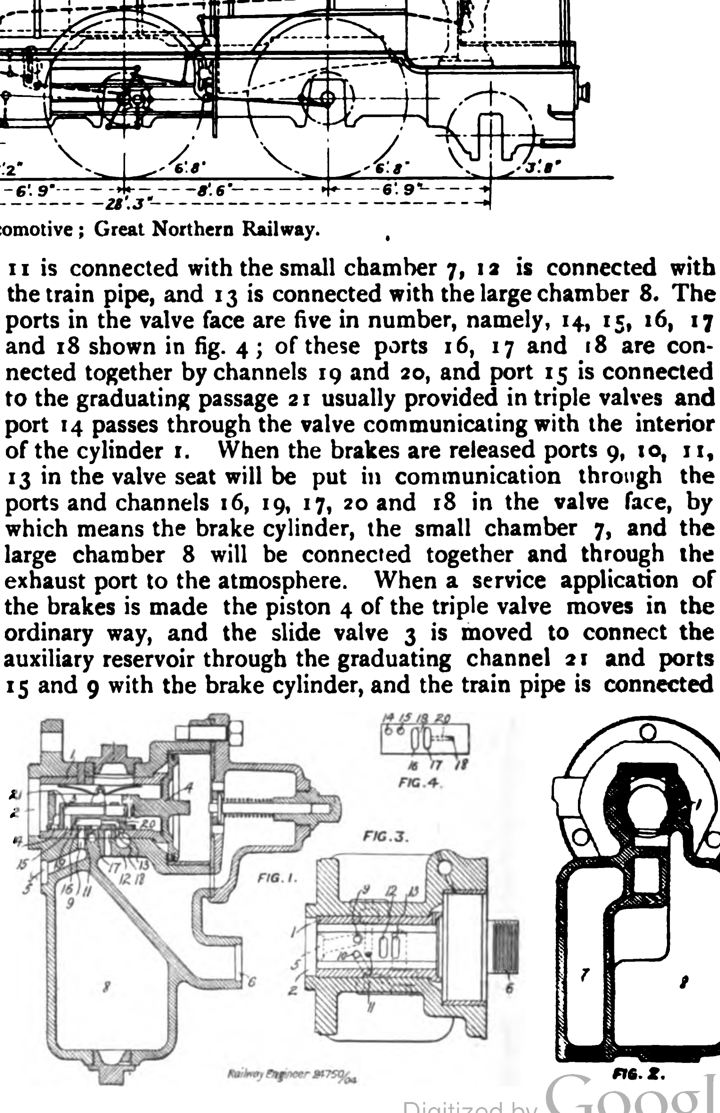
The tender carries 5 tons of coal and 3,670 gallons of water. It weighs 40 tons 18 cwts.

Recent Patents relating to Railways.

These abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d*. each.

Air Brakes. *24,750. 15th November, 1904. J. W. Cloud, 82, York Road, King's Cross, London.*

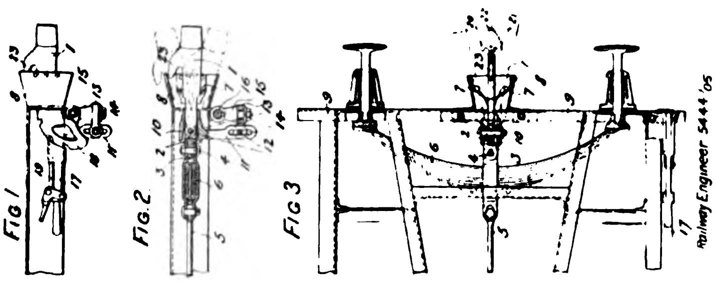
This invention has reference to a special arrangement of ports in the triple valve and its seating, whereby the function of accelerating the partial application of the brakes, or the functions of accelerating both the partial and full application of the brakes, is performed by the triple valve slide valve alone. The triple valve piston 4, has mounted on its stem the slide valve 3, co-operating with a valve seat formed in the valve cylinder 1; these parts, as will be seen from figs. 3 and 4, having their port openings different from what is usual in triple valves, so that two functions—that of applying and releasing the brakes and also voiding the train pipe to the small and large chambers 7, 8, may be accomplished by the movement of the valve. In the valve seat five ports are provided, of these 9 communicates through the passage 5 with the brake cylinder, 10 is connected with the atmospheric or exhaust port, 11 is connected with the small chamber 7, 12 is connected with the train pipe, and 13 is connected with the large chamber 8. The ports in the valve face are five in number, namely, 14, 15, 16, 17 and 18 shown in fig. 4; of these ports 16, 17 and 18 are connected together by channels 19 and 20, and port 15 is connected to the graduating passage 21 usually provided in triple valves and port 14 passes through the valve communicating with the interior of the cylinder 1. When the brakes are released ports 9, 10, 11, 13 in the valve seat will be put in communication through the ports and channels 16, 19, 17, 20 and 18 in the valve face, by which means the brake cylinder, the small chamber 7, and the large chamber 8 will be connected together and through the exhaust port to the atmosphere. When a service application of the brakes is made the piston 4 of the triple valve moves in the ordinary way, and the slide valve 3 is moved to connect the auxiliary reservoir through the graduating channel 21 and ports 15 and 9 with the brake cylinder, and the train pipe is connected



through port 12, port 17, channel 19, port 16 and port 11 with the small chamber 7. By this means the application of the brakes will be accelerated, at the same time a gradual increase of the brake pressure by means of the graduating valve is not interfered with thereafter. When the pressure in the train pipe is lowered sufficiently to secure a full application of the brakes the triple valve piston 4 will be moved further, and the slide valve 3 will be caused to connect the train pipe through port 12, port 16, channel 19, ports 17 and 13 with the large chamber 8, and the brake cylinder will be connected through channel 5, ports 9 and 14 with the auxiliary reservoir. In this manner a quickened full application of the brakes is obtained. Raising the train pipe pressure will return the triple valve piston 4 to its first position, in which the brakes are released in the ordinary manner. (*Accepted 17th August, 1905*).

Couplings, Automatic. *5,444. 15th March, 1905. G. Bain, Carriage and Wagon Works Manager, Egyptian State Railways, Cairo.*

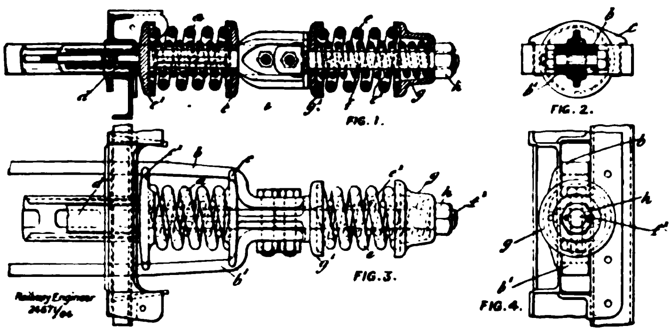
The coupling-bar is formed with two lateral hooks 20, 21 and a vertical hook 23, and is mounted at its inner end on a horizontal pivot 2, carried by a joint piece 3 interposed between the coupling-bar and the draw-bar, the intermediate part 3 being connected to the draw-bar by a vertical pivot 4. With this construction which ever side the pointed end of the coupling-bar comes into contact with the point of the coupling-bar of the next vehicle, coupling will take place, and in the act of coupling the coupling-bar and the intermediate connecting piece will both be rocked—against the action of springs carried in a box on the



head stock—about the vertical pivot connecting the intermediate part with the draw-bar, while when uncoupling the intermediate part will not receive motion, but the coupling-bar alone will be rocked in a vertical plane about its horizontal pivot pin on the intermediate part. To rock the coupling-bar for uncoupling in a vertical plane, the coupling-bar passes through a sleeve, from which an arm extends connected to a shaft extending transversely across the end of the vehicle, and then by rocking the shaft the coupling-bar is moved on its horizontal pivot by means of the sleeve through which it passes. (*Accepted 17th August, 1905.*)

Buffing and Draw Gear. *24,671. 14th November, 1904. J. Willison, 158, Clarence Road, Derby.*

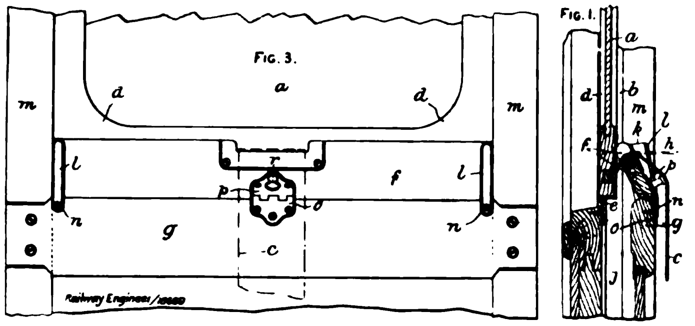
This invention relates to springs for holding in, or restoring the



gear to its central position. Such springs, which are normally subjected to an initial compression, have in time a permanent set imparted to them, so that the initial compression becomes ineffective for centreing purposes. According to the present invention the spring used for this purpose is a double coil helical spring the inner coil of which is of greater length than the outer The spring is placed under an initial compression between fol lower and abutment plates suitably mounted on the draft gear, one of the plates being stepped to accommodate the two coils and also place the inner coil under a greater total compression than the outer coil. By this arrangement when the outer coil has acquired a permanent set which so reduces or eliminates its normal compression that it is no longer useful for centreing the gear, the inner coil still retains sufficient normal compression to produce the required centreing action. The spring may be reinforced for draft and buffing purposes by a second similar spring, which may have an elongated inner coil, arranged in tandem fashion so as to offer twice the resistance of the single spring for the same translational displacement. (*Accepted 3rd August, 1905.*)

Carriage Windows. *18,669. 29th August, 1904. E. J. Hill, 11, Victoria Street, Westminster.*

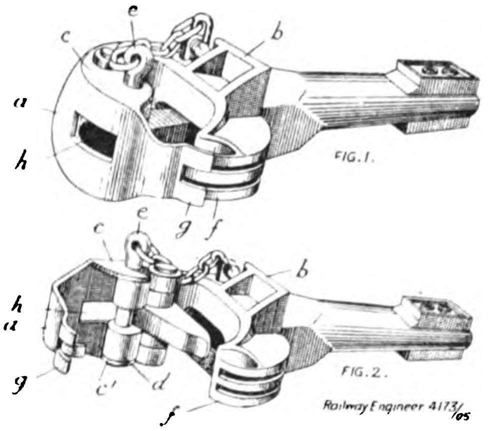
This invention relates to sash windows for carriage doors wherein a hinged flap *f* acts as a movable abutment or guide for the strap *c*, and has for its object to prevent excessive movement of the



flap in the inward direction. For this purpose a pair of stops, each formed of an angle plate *k l*, are fixed to the window frame styles and garnish rail. The flap *f* is mounted on a single central hinge *o p*, which carries the stud *r* for holding the lifting strap. (*Accepted 3rd August, 1905.*)

Couplings. *4,173. 28th February, 1905. Edgar Allen and Co., Ltd., Imperial Steel Works, Sheffield. (A communication from P. A. Hyde, then chief locomotive superintendent, Central South African Railways, Pretoria).*

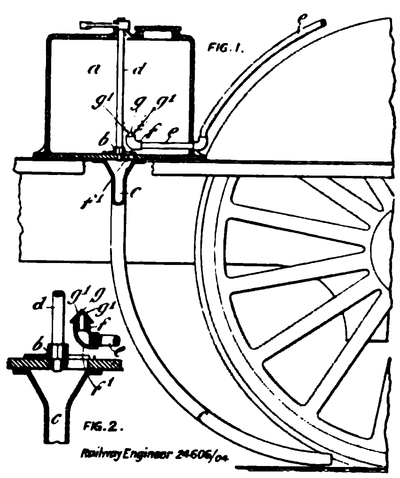
This invention consists of improved means for adapting American standard automatic couplings for use with central buffer pin-and-link couplings. For this purpose a laterally curved plate *a* is attached to the front of the automatic coupling *b* by perforated top and bottom ears *c* c^1, through which the coupling pin *e* is passed.



The plate *a* is adapted to bear on one side against the knuckle *d* of the automatic coupling, and is provided on the other side with a forked extension *g*, which bears upon and embraces the smaller horn *f* of the coupling. In the centre of the plate is an aperture *h* for the passage of the link of the adjacent coupling. (*Accepted 24th August, 1905.*)

Sand Boxes. *24,606. 14th November, 1904. T. Boardman, Beach House, Oystermouth Road, Swansea.*

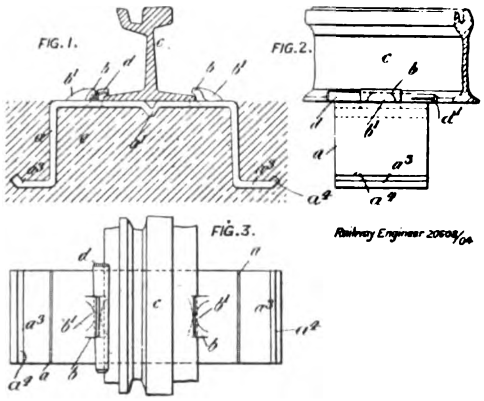
According to this invention the sand is damped while in the sand box by hot water and steam introduced by a pipe communicating with the boiler or the water space of the fire box, and the damp sand is, when required, fed down the sand delivery pipe to the rails in a damp state by the agency of the water and steam acting on it. Thus the advantage of using the sand in a damp state is obtained and without clogging the sand box valve or the sand delivery pipe. Communication between the sand box and the boiler or water space of the fire box is made by a pipe *e*, which is



fitted with a controlling cock or valve. A perforated nozzle is provided on the said pipe inside the sand box. When it is required to feed sand to the railway rails the sand pipe valve, which is of usual kind, is operated to open the way to the sand delivery pipe *c*, and at the same time water and steam are turned into the sand box through the nozzle *g*. The upper perforations in the nozzle are arranged to direct the sprays of water and steam so as to distribute the introduced water and steam in the sand, and, whilst damping the sand, to dislodge it for discharge to the sand delivery pipe down which the sand is impelled by a spray of water and steam issuing from the lower part of the nozzle. (*Accepted 10th August, 1905.*)

Rail Chairs and Joints. *20,508. 23rd September, 1904. A. Macleod-Carey, 2, Woodlands Terrace, Middlesbrough-on-Tees, York.*

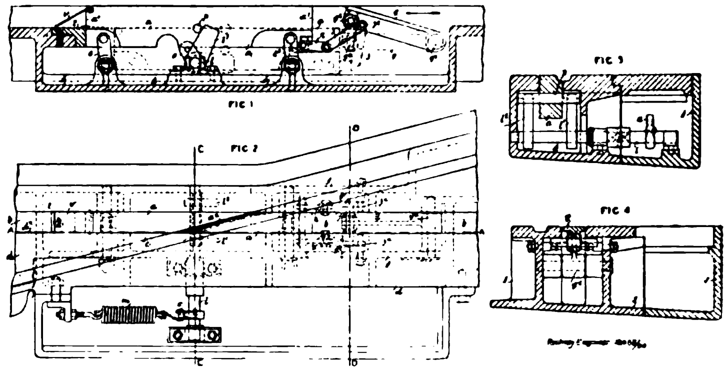
The chair or anchor comprises a plate of iron or steel of suitable dimensions, which, by means of a rolling operation or pressure, is caused to assume approximately a **U**-shape in cross section. This,



when inverted, serves as an elastic support for the foot or bottom flange of the rail, the latter being secured by means of a shaped tapered wedge or key forced between the lateral edge of the bottom flange and a clip formed on the upper face of the plate during the shaping or pressing operation at a slight angle or in a slanting direction to the square of the plate. The clips may be stiffened or strengthened by bowed or shouldered portions or buttresses also produced in the pressing or shaping operation. The chair *a* is capable of being embedded in the concrete *e* or other material of the track or permanent way, leaving the clips *b* always free for the fitting of the rails without disturbing the chairs. (*Accepted 24th August, 1905.*)

Level Crossings. *18,468. 26th August, 1904. W. J. Hollick, 3, Humphrey Street, Old Trafford, Manchester.*

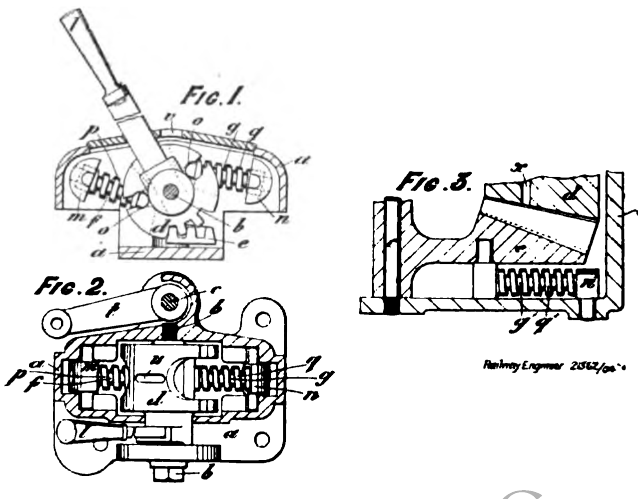
This invention provides means for temporarily filling up the gaps or spaces between the ends of tramway or other rails at level



crossings, which are required for the flanges of wheels to pass. A metal block or small piece of rail *a* arranged to fit the gap is connected to bell crank or other levers *e* e^1, which are acted upon by the wheels of the tramcar to cause the blocks to rise and fill the gaps. Or the blocks may be arranged to normally fill the gap, but so as to be depressed by the wheels of a passing train. (*Accepted 24th August, 1905.*)

Switch Mechanism. *21,362. 5th October, 1904. H. A. Thomson, 2, Grantly Gardens, Shawlands, Glasgow.*

Two segmental toothed wheels *d*, *e* are mounted to turn on spindles *b*, *c* in a box *a*, the wheel *d* being in gear with the wheel *e* and having a lever handle *l*. On the rim of wheel *d*, two toggle arms *f* and *g* of **T** shape are securely recessed and fulcrumed. The cross piece of each of these toggle arms is of D form to enable it to pass through two eyes, cored on the wheel rim, and to retain its fulcrumed position within the circular cavity *o*. The other ends of the arms are fitted to slide in collars *m* and *n* pivoted in the casing. Round each arm *f* and *g* a spiral compression spring *p* and *q* is coiled. The bevel wheel *e* forms part of a bell crank lever *t* to one end of which it is cast, the other end being attached to the pull rod of the points. For the purpose of lubricating the spindle *b* and teeth of wheels *d* and *e*, an aperture *v* is provided in the cover of the casing to communicate with a slot *w* which extends downwards to the spindle *b*, and from thence by a hole *x* to the wheel teeth. In a modified arrangement shown by figure 3 the toggle arm g^1, with the spring q^1, is fulcrumed on the wheel *e* figure 3, the other end of the arm being fitted to slide in the collar n^1. On operating the lower handle *l*, circular motion is transmitted to the wheels *d* and *e* and from thence to the pull



rod of the points. Also when the switch blades are run through trailing-ways by the flanged wheels of a train or vehicle and changed to another set position, the motion thus given to the switch blades and conveyed through the point rod to the lever *t* reverses the switch mechanism, and the springs retain the points in their changed position. (*Accepted 24th August, 1905*).

SPECIFICATIONS PUBLISHED.

A.D. 1904.

17362. Working of railway points and signals. Descubes.
18060. Electro-mechanical apparatus for automatically operating the rail and electrical conductor points on electric tramways and railways from the tram or train. Parr.
18468. Tramway lines and railway lines at level crossings. Hollick.
18661. Railway traffic control systems. Rowe.
18669. Railway carriage and similar sash windows. Hill.
18901. Apparatus for recording the movements of locomotives, vehicles or machinery. Collet.
19889. Electro-magnetic mechanism, particularly applicable to railway signalling apparatus. British Thomson-Houston Co., Ltd. (General Electric Co.)
20508. Means for anchoring and securing flat-bottomed rails in the permanent way of railways and tramways. Macleod-Carey.
21003. Furnaces of locomotive and like boilers. Crosthwaite.
21362. Working of switch points of railways. Thomson.
21582. Couplings for the draw-gear and pipes or other coupled parts of railway and similar vehicles. Coles.
21722. Rail joints and electrical bonds connected therewith. Radford.
22736. Railway rail joints. Borschall.
22746. Switch rails for tramways and the like. Kneen.
24606. Feeding sand from the sand-boxes of railway locomotive engines to the railway rails and apparatus therefor. Boardman.·
24671. Draft and buffing mechanism for railway carriages. Willison.
24750. Fluid pressure brake apparatus for railway and other vehicles. Cloud.
27217. A device for indicating the names of stations on railway lines in the passenger compartments of railway carriages. Esser.
29447. Couplings for railway vehicles. Brandau.

1905.

103. Couplings for railway trucks. Dyer.
327. Grinding machine or apparatus to be used principally for levelling the corrugations or undulations on the surfaces of grooved rails, applicable also to other purposes. Forster.
2923. Valves for air brake systems. Allison (Levy).
3630. Radial trucks for tramway and like vehicles. Cook.
4173. Means for adapting American standard automatic couplings for use with central buffer pin and link couplings. Edgar Allen and Co., Ltd. (Hyde).
5444. Railway carriage and waggon automatic safety coupling. Bain.
6073. Electrical mercury switches operated by a vehicle passing along a railway. Siemens Bros. and Co., Ltd. (Siemens and Halske, Act. Ges.).
6739. Composite railway sleepers. Michels Composite Sleepers, Ltd.
8715. Mechanism for placing explosive fog signals in position and removing same when exploded. Downing.
8790. Relief-valve for locomotive cylinders and the like. Robinson.
8837. Couplings for railway carriages or the like. Novak.
10183. Rail fasteners or chairs for railways. Mace.
11185. Railway spike. Clements.
11692. Car couplings. Timms.

Ferro-Concrete, and some of its most Characteristic Applications in Belgium.*

By M. ED. NOAILLON, of Chênée, near Liége.

(*Continued from page 311*).

The dome of the Central Railway Station at Antwerp springs from the level of the roofs of the mass of buildings of the station at a height of 130ft. above ground level and rises another 130ft. to the spire. It is entirely constructed of ferro-concrete by the firm of Vasanne of Brussels. The work was originally intended to be built in stone, but it was discovered that the foundations would not carry such a weight, and therefore ferro-concrete was preferred, as it could be built hollow. However, it was necessary to follow minutely the form of the original design, which, rationally conceived for a massive material like stone, often presented serious difficulties of execution in ferro-concrete.

The dome comprises four large glass lights placed upon the sides of a square, and upon these rests the actual dome which in its turn supports a campanile. Each glass light is in the form of a gallery with seven arcades surrounded by a demi-arch of 32·8ft. radius. The arches are framed by an archivault of 11·5ft. height, which receives at its periphery the haunches of the dome.

The entire structure, which is 1,800 tons in weight, rests entirely upon the columns at the angles of the glass lights, for it was only at these points that a solid support could be obtained. These columns are Y shaped in the cross section, which has an area of 10·7 sq. ft., and they are subdivided at the height of the centres of the arches into three beams.

The tail of the Y is extended in the diagonal plane in the form of a thrust block rising obliquely between the two shells of the dome. Each of the limbs of the Y forms the abutment of the beams in the arch, 8·2ft. high, situated in the archivault. In the horizontal plane passing through the tops of the archivaults is placed a beam in the form of a flat ring 4·92ft. wide, which is supported at eight equidistant points, which are the four tops of the archivaults and the four ends of the thrust blocks.

This beam serves two purposes—it balances the horizontal reactions due to the obliquity of the thrust blocks, and resists the tensile stress created by the joists of the dome. At the top of each beam of the archivault are hooked two tie-rods which go down in the two midribs of the arches and extend into the two central columns of the gallery of arcades, and support in its place a horizontal beam hidden in the entablature of the gallery, and supporting all the lights; it is obvious, therefore, that all the weight of the latter is supported by the columns.

The dome consists of two superposed shells at a distnace apart varying from 3·28ft. to 6·56ft. The internal shell which forms the ceiling of the entrance hall is completely decorated with sunk moulded panels; some are round and others square, and they diminish in depth and size progressively from the springing to the summit.

They leave only flat bands on the inside of the shell, and these follow a series of meridians and parallels. A part of these flat bands are formed by a skeleton of joists and trimmers which are supported on the annular beam, and they carry the whole weight of the dome. This skeleton was first erected, and served to support the cores which formed the moulds for the panels, and then the latter were filled in with concrete.

The external shell has a uniform thickness of 3·15ins., and it is relieved by six moulded ribs following meridian lines. It is supported upon the internal shell by small distance pieces normal to the two surfaces; this method of support has been chosen to allow as much freedom as possible for the unequal expansion of the shell owing to the rays of the sun striking it obliquely.

The most interesting feature of the construction of the dome of the Antwerp station is that all the mouldings and all the sculptures, which are so numerous and of so many different forms, have been executed by direct moulding, and not, as is usually the case, by rough applications which are trued up afterwards by gauge boards.

It would never have been possible to make in wood the numberless moulds which would have been needed for the latter process, particularly as the work had to be done upon surfaces bent often in two directions like the panels of the dome.

M. Vasanne has invented a very ingenious system of moulding. He begins by executing in plaster the model of the sculptures which are to be reproduced in the concrete. He then spreads upon this negative mould a layer of 1·2 to 2ins. thickness of a paste made of sawdust and magnesium oxychloride. This paste hardens rapidly and gives him the desired mould, which is light, strong, and can be worked like wood; the same negative mould can be used several times.

The manufacture of the glass lights was specially difficult because of the great richness of the ornamentation and of the exactitude with which the moulds had to be made to obtain a perfect fitting of the different mouldings. The part of the glass lights which forms a gallery was filled with concrete at one operation in a mould built up in position on the site.

* Read before the Institution of Mechanical Engineers at Liége, June, 1905.

With regard to the part in the form of a half rose, a complete mould was arranged upon a perfectly level platform. This mould showed, therefore, in hollow all one face of the half rose.

The concrete was moulded to a thickness of 2ins., and then the moulded part was cut into portions specially marked. Then the moulding, followed by the same division into parts, was repeated to obtain the opposite face. In this way two corresponding portions placed back to back formed one hollow structure representing one element of the glass light. The parts were then used to build up the light, just as stones would have been employed, but care was taken to pass bars of iron into the hollow part, and then to pour in concrete, so as to obtain a monolithic structure which possesses great rigidity.

Renommée Hall at Liége was built entirely of ferro-concrete by the firm Perraud and Dumas of Brussels.

In opposition to what took place in the design for the dome at Antwerp, the general arrangement, the style and proportions of all the parts of the building were specially thought out by the architect, M. Jaspar, so as to be the most suitable for construction in ferro-concrete, and in order to use the properties of that material to the best possible advantage. It was desired to oppose the tendency to make concrete merely play the part of a servile imitator of stone, by the employment of a characteristic design which should indicate the nature of the material used.

The principal hall is covered by three cupolas, each 55ft. diameter, placed at a height of about 50ft. above the level of the ground. Each cupola forms part of a sphere which continues in haunches pierced with lights and descending to the corners of the circumscribed square. The intersections of the spheres with the vertical planes passing through the sides of the squares are formed by arched beams which spring from the capitals of short cylindrical columns. The cupolas are 4½ins. thick and are made of concrete composed of cement and clinker finely broken up; they are re-inforced by a layer of expanded metal and with a lattice work of bars. The centering of the first cupola was carried out upon a new design. In order to avoid the great expense entailed by the construction in wood of a spherical centering, a skeleton was built up of ironwork consisting of 16 bars, each 1½ins. dia., fixed upon the meridian lines like the ribs of an umbrella, and these were interlaced upon parallel horizontal circles by other weaker bars. The whole skeleton was then covered with sheets of expanded metal, which were designed as the first re-inforcement, and afterwards the concrete was put on above and below so as to completely surround the expanded metal, which thus acted as its own centering, and it was merely necessary to render the surface up to the required thickness.

The bars of the skeleton were then removed and used for the other cupolas, and they were finally intended for re-inforcing the beams. Unfortunately this system of centering was found to be wanting in rigidity, and it was necessary to use the wood centering after all.

The roof of the galleries and the spherical triangles between the cupolas form a terrace of 957 sq. yds. area, which serves as a promenade. The concrete of the cupolas and the terraces is not rendered in cement, it is made watertight by a large layer of rubberöid.

The principal hall is lighted upon its two long sides by six semi-circular glass lights, each 52·5ft. diameter, framed by arched beams. The spandrils are formed by panels of ferro-concrete showing on the inside ornament in relief; the moulding was done in the workshop, and then each panel was cut into portions that were erected in position.

In spite of the complete absence of mouldings, which were left out to facilitate the centering, the hall is of most elegant appearance owing to its satisfactory design.

Widening of the La Boverie Bridge at Liége.—This bridge is 147 yds. long. The width has been increased from 32·1ft. to 46·3ft. by means of two platforms corbelled out at each side of the bridge.

At each end these platforms are extended so as to meet the quays by wide quadrants.

The corbelling, fig. 6, is carried out by a platform 5·9ins. thick, supported at intervals of 6·56ft. by brackets 11·8ins. thick, by 19·7ins. in height at the back. The method of fixing these brackets is interesting. Cutting and pinning brackets into the old structure presented serious difficulties, as it would have been necessary to cut deeply into the ashlar work and to destroy the keystones in the arches, which would have been very unwise. The author of the design, M. Prangey, engineer of roads and bridges, got over the difficulty in a very satisfactory manner by fixing the brackets in pairs opposite one another. The brackets were made independently two months before they were needed; the three round bars, 1·22in. diameter, which formed their reinforcement in tension, were left projecting beyond the concrete about a yard, and the ends were screwed. The brackets were put in position, a pair at a time, by means of two cranes, and as soon as their bases had been entered into the recesses cut in the masonry of the bridge the ends of the three pairs of bars were coupled together by means of three tie-bars which crossed

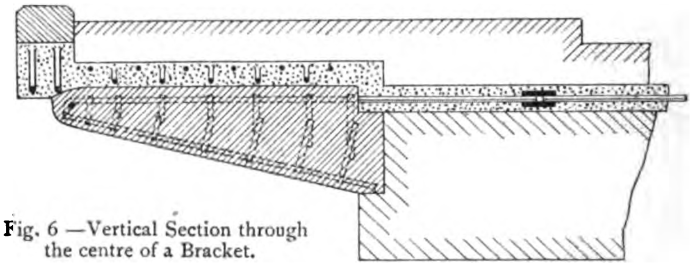


Fig. 6 —Vertical Section through the centre of a Bracket.

the roadway, and these tie-rods were provided with long sleeves threaded to fit the ends of the screwed bars. In this way each pair of brackets were mutually self-sustaining, and the cranes could leave them fixed. It was merely necessary then to level them up carefully by tightening or slackening the screwed sleeves, and then to pin them permanently in position by running in cement grouting round the ends of the brackets in the masonry.

All the tie-bars are embedded in a layer of concrete 6·3ins. thick, which extends across the roadway and serves to constitute the gutter to carry off the water which percolates through.

The platform, which is supported by the brackets, is calculated for a distributed load of 80 lbs. per square foot, and was tested up to 160 lbs. per square foot without suffering any appreciable deflection.

The Bridge at La Boverie Island upon the Branch at Liége was built upon the Hennebique system by the Dulac Company, under the direction of the engineer, M. Prax. The chief details of the work are: Length between abutments 260ft., comprising a central span of 180ft. and two side spans each 32·8ft. wide. The total width of the roadway is 32·8ft. The span of 180ft. is the full width of the river-bed; the soffit of the arch is an arc of a circle with a rise at the crown of about 12ft., or a proportion of rise to span of about 1 in 85.

(To be Continued.)

New South Wales Government Railways and Tramways, 1904-05.*

THE report of the railway commissioners—Messrs. Chas. Oliver (*chief*), David Kirkcaldie and W. M. Fehon—upon the operation of the N.S.W. Government railways and tramways during the year ended June 30th, 1905, states that:—

Railways.—The number of miles of line open for traffic on the 30th June was 3,280¾—the same as last year; nevertheless the capital has increased by £774,033, of which £600,000 represents a sum advanced by the Government about 25 years ago for the purchase of material and general stores, which a special Committee appointed by the last Government recommended should be added to the capital account, and that has now been done for the first time. The same Committee recommended (and the Government endorsed the recommendation) that the sum of £456,639

*For an abstract of the report for the year 1903-4, see *The Railway Engineer*, November, 1904, p. 372.

(£434,184 for railways and £22,455 for tramways) having been defrayed from the Consolidated Revenue, and therefore not a debit against the State, should be regarded as "Non-interest bearing capital."

The interest due on the capital invested, calculated at 3·582 per cent. (the average rate of interest on the State debt), amounts to £1,526,948, and the net earnings were £35,079 short of that sum.

The number of passengers carried shows an increase of 1,365,461 (£12,941), and goods and live stock traffic an increase of 67,456 tons (£234,662).

There was an increase during the year of 67,383 train miles.

The percentage of working expenses to revenue has been reduced from 65·74 last year to 59·50, being an improvement of 6·24.

With the exception of minerals (other than coal and coke), all classes of traffic contributed to this improved result.

An agreement was completed between New South Wales, South Australia, and Victoria, providing for an adjustment in these three States of the rates for all traffic to and from districts in respect of which competition has existed for many years past. This agreement, which became effective on the 1st March last, is for the term of one year, subject thereafter to termination on three months' notice from any of the parties, but it is confidently anticipated that it will constitute the basis of a permanent settlement of this long-standing difference. It provides that all rates on traffic to or from the competitive districts shall be made public, and that no special rebates or concessions of any kind shall be given to secure such traffic. The adjustment of the rates under this agreement is such that, while augmenting the revenue of the State Railways concerned, the same proportion of the traffic affected will, it is believed, be obtained for each State as was previously secured, thus conserving the commercial interests of the respective States. All preferential rates which could be considered as inconsistent with the provisions of the Commonwealth of Australia Constitution Act have been abolished.

By the continued introduction of safety appliances, and the exercise of care on the part of the staff, 35,158,150 passengers were carried during the year without any train accident resulting in loss of life.

The re-laying, re-railing, and re-sleepering of the permanent way has been continued: 161m. 60ch. were renewed; 249m. 21ch. were lifted and re-ballasted, 69,053 cubic yards of basalt or hardstone ballast being used. With the view of facilitating the supply of ballast and reducing the cost of maintenance, a large new quarry has been opened at Bombo, the crushers and machinery being operated by electric power. Between Hurstville and Como the reduction of the gradients from 1 in 60 to 1 in 80 were completed; and those between Rydal and Sodwalls are being reduced from 1 in 55 to 1 in 75. In connection with the renewal and general maintenance of the permanent way and works a sum of £491,164 has been expended during the year and charged to working expenses.

For rebuilding and replacing engines, carriages and waggons, £98,627 and for general upkeep £372,614 were charged to working expenses.

A coal elevator (with crushers for large coal) capable of storing 1,000 tons of coal in bins, and discharging it into locomotive tenders by gravitation, has been put up at Penrith. The elevator will also deal with ashes from the engine-pits and load them into trucks.

Results of the Working.

Expended on construction and equipment ...	£43,062,550
Cost per mile open for traffic	£13,126
Total miles open for traffic	3,280¾
Earnings	£3,684,016
Working expenses	£2,192,147
Balance	£1,491,869
Profit to capital invested %	£3 : 9 : 3
Working expenses to earnings %	59·50
Per average mile open earnings	£1,123
" " " working expenses	£668
" " " return	£455
Per train mile earnings	s. 7 d. 0½
Per train mile working expenses	4 2¼
" " return	2 10¼
Passenger journeys, No.	35,158,150
Goods tonnage	6,549,791
Live-stock tonnage	174,424
Train mileage	10,467,886

Summary of ton mileage for the year:—

Description of Traffic.	Total Tons Carried.	Total Miles.	Average Miles per Ton.	Earnings, exclu. of Terminals.	per Ton per Mile.	Each Class to Total Weight.
				£	d.	%
Coal, Coke, Shale ...	3,863,457	73,624,368	19·06	194,836	·61	60·19
Other Minerals	233,172	9,278,064	39·80	31,213	·81	3·63
Crude Ores ...	135,773	17,620,124	129·77	33,099	·45	2·12
Miscellaneous...	245,991	11,944,037	48·14	45,214	·91	3·83
Firewood ...	225,397	6,117,274	27·14	20,109	·79	3·51
Fruit	40,435	3,105,410	76·80	13,464	1·04	·63
Grain, &c., "Up"	522,755	131,684,482	251·90	237,389	·43	8·15
Hay, Straw, Chaff ...	139,974	27,346,952	195·37	45,988	·40	2·18
Frozen Meat ...	23	2,232	97·00	9	·97	·00
General (truck loads) ...	3,291	1,198,503	364·18	12,214	2·45	·05
A Class ...	324,941	29,765,523	91·6)	117,355	·95	5·06
B " ...	166.758	17,402,049	104·35	123,125	1·70	2·60
C " ...	63,075	7,673,832	121·66	61,637	1·93	·98
1 " ...	61,122	8,779,220	143·63	108,299	2·96	·95
2 " ...	39,420	6,296,440	159·75	89,054	3·39	·62
3 " ...	88,016	13,944,c65	158·43	267,819	4·61	1·37
Wool... ...	90,572	26,793,810	295·83	199,931	1·79	1·41
Live Stock ...	174,424	44,839,865	257·07	298,484	1·60	2·72
Total ...	6,418,596	437,416,250	68·15	1,899,239	1·04	100·

Miscellaneous traffic consists of timber, bark, firewood. bricks, drain pipes, coal, road metal in 6-ton lots, agricultural and vegetable seeds in 5-ton lots, and traffic of a similar nature.

A and B classes consist of lime, vegetables, tobacco leaf, caustic soda and potash, cement, copper ingots, fat and tallow, water and mining plant, 6-ton lots; leather, 1 and 3-ton lots; agricultural implements in 5-ton lots; and other traffic of a similar nature.

This statement does not include 305,619 tons of coal, on which only shunting and haulage are collected; nor does it include £21,721 for haulage, tonnage dues, &c.

Summary of the mileage of suburban (within 22 miles of Sydney and Newcastle only) passengers:—

Ordinary Passengers...	No.	14,359,193
Season Ticket Holders' Journeys	"	8,798,700
Workmen's Journeys...	"	8,022,876
Total Passengers' Journeys	"	31,180,769
Miles Travelled	Miles	188,067,952
Per Passenger	" ...	6·03
Revenue from Passengers...	£	366,855
Average per Pass. per Mile	d.	0·47

Summary of the mileage of passengers on the Extended (beyond 22 but within 34 miles of Sydney and Newcastle) Suburban Section:—

Passengers	No.	674,728
Miles Travelled	"	16,536,400
Average per Passenger	Miles	24·51
Revenue from Passengers	£	34,089
Average per Pass. per Mile	d.	0·49

Tramways.—The number of miles of line open for traffic on the 30th June was 125¾, and the amount spent on construction and equipment, £3,637,922; of this sum £22,455 was paid from the Consolidated Revenue, and no interest is payable thereon. The interest due on the capital invested, calculated at 3·582 per cent. (the average rate of interest on the State debt), amounts to £129,506, and the net earnings were £1,619 short of that sum. The cost per mile open was £28,931; the earnings, £813,539; the working expenses, £685,682 (84·28%); percentage of profit on the capital invested £3 10*s.* 4*d.*; earnings per mile open, £6,470, and per tram mile 12*d.*; passengers carried, 139,669,459; tram miles, 16,413,762.

The earnings increased by £10,584 and the expenditure by £12,057, a decrease of £1,473.

New Zealand Government Railways; 1905.*

The annual statement by the Minister for Railways, the Hon. Sir J. G. Ward, K.C.M.G., showed that the working of the New Zealand Government railways during the year ended 31st March, 1905, had again been satisfactory. The total earnings were £2,209,231, and the total working expenditure £1,492,900, the profit being £716,331.

The length open for traffic at close of the financial year was 2,374 miles—an increase of 46 miles—the average length open for traffic was 2,347.

The capital cost of lines open, and the Lake Wakatipu steamers, has increased during the year from £20,692,911 to £21,701,572.

The net revenue, £716,331, is equal to a return of 3·30 per cent. on the capital invested in the open lines, and 3·11 per cent. for the total capital, £23,003,704, invested in opened and unopened lines.

The train miles run were 6,107,079, an increase of 421,680 train miles, which include permanent additions to the time tables of 283,345 train miles, costing £69,000.

The average lateness in minutes of the principal trains was:—

Long-distance passenger trains...	1·07	against	0·80	in 1904.
Suburban trains	0·30	„	0·32	„
Long-distance mixed trains ...	1·15	„	1·05	„

The ordinary passenger traffic continues to maintain that elasticity which has been so remarkable a feature of the business during the past ten years. The number of such passengers carried was 8,514,112, an increase 207,729; season tickets, 140,453, an increase of 10,534; "workers' twelve-trip tickets" and "workers' weekly tickets," 111,303, an increase of 9,246. The number of workers' tickets issued represents 79 per cent. of the total season-ticket business, but the revenue obtained from them is 22·41 per cent. only of the total amount derived from the issue of season tickets, which for the year under review amounted to £57,252. The holiday-excursion tickets issued during the year numbered 693,453, a decrease of 1,931 on the issues for the previous year. The total issue of "school, factory and friendly societies' excursions" was 113,659, an increase of 1,976.

The coaching traffic shows satisfactory increases, viz.: Parcels, 26,668; horses, 1,022; carriages, 172; dogs, 1,776.

In the goods traffic cattle increased by 3,489 head; pigs, 7,500 head; wool, 6,310 tons; firewood, 3,108 tons; minerals, 62,037 tons. The decreases are—sheep, 343,394 head; chaff, lime, &c., 848 tons; timber, 16,385 tons; grain, 87,973 tons; merchandise, 27,312 tons. Having in view the enormous and unprecedented increase in sheep traffic during 1903 it is not surprising to find a decrease in sheep business for the years 1904 and 1905. The serious effect which the export of large numbers of ewe lambs during the two preceding years has had on the flocks of the colony is shown by the statistics published by the Agricultural Department, from which it appears that the sheep in the colony on the 31st March, 1904, numbered 1,388,174 head less than on the 31st March, 1903. This depletion of the flocks naturally reflects on the business of the railways.

Of the 14 locomotives added to the stock, 7 were built in the railway workshops, and 7 under contract by Messrs. Price Bros., of Thames. The additions and improvements made to the rolling-stock during the year have increased the tractive power by 5·73 per cent., the passenger accommodation by 8·74 per cent., and wagon carrying-capacity by 5½ per cent. The wagons added to the stock have a carrying-capacity equal to 836 of the old style 6-ton four-wheeled wagons. The cushioning of second-class-car seats has now been practically completed, 498 such cars having been fitted with cushions; 304 cars have also been fitted with lavatories.

The average number of men employed was 9,361, against 8,782 last year.

Seven appeals against decisions of the Department were heard by the Railway Appeal Boards, two of which were allowed and five dismissed.

The gross revenue, £2,209,231, exceeded the estimate by £29,231. The net revenue was £25,586 less than that of the preceding year. Passenger receipts increased by £28,825; season tickets, £4,672; coaching traffic, £4,900; miscellaneous, £6,993. Goods revenue has decreased by £15,193, and rents and commissions by £1,607.

The earnings of the Lake Wakatipu steamers amounted to £5,897, against £6,997 last year. The net return was equal to 4·25 per cent. on the capital cost (£16,436), which, in view of the fact that the business diverted from the steamers has gone to the railway, is very satisfactory.

The total expenditure, £1,492,900, was divided as under:—

	£	Per Cent. of Revenue.
Traffic	402,715	18·28
Locomotive	535,635	24·31
Maintenance	508,735	23·09
Management	68,353	3·10
	1,515,438	68·78
Less credit recoveries ...	27,736	1·26
	1,487,702	67·52
Lake Wakatipu steamers ...	5,198	0·06
	£1,492,900	67·58

The amount expended on maintenance of line, buildings and other structures, £508,735, is an increase of £17,916 on the amount spent during the previous year, and gives an average expenditure of £216·64 per mile, against £212·94 per mile for the preceding year, an increase of £3·70 per mile. Additions and improvements to lines and structures, costing £12,391, which might fairly have been charged to capital, have been made during the year and charged to working expenses. The expenditure on account of bridge renewals and repairs amount to £62,083, all of which was debited to working expenses.

Summary of results of working for year ended March 31st, 1905:—

Miles open for traffic	2,374
Capital, open and unopen lines ...	£23,003,704
Capital, open lines	£21,701,572
Capital, per mile of open lines	£9,141
Gross earnings	£2,209,231
Working expenses	£1,492,900
Profit on working	£716,331
Per cent. on capital	3·30
Working expenses to earnings	67·58%
Earnings per average mile open ...	£938
Working expenses per do.	£634
Profit per do.	£304
Earnings per train mile	86·50d.
Working expenses per do.	58·46d.
Net earnings per do.	28·04d.
Passengers, ordinary	8,514,112
Season tickets	140,453
Goods tonnage	4,011,511
Live stock tonnage	173,956
Train mileage	6,107,079
Locomotives	389
Passenger cars	864
Wagons and brake vans	13,885

Steady progress has been made during the year in the important matter of extending the safety appliances. Signals and interlocked points were fitted at several points, and 66 tablet instruments and 85 miles of line fitted up and tablet working installed. Other extensions of tablet system are in hand, and will be vigorously pushed forward. The installation of these instruments adds very materially to the safety of the travelling public. The staff-and-ticket system of block working was extended. This appliance, like the tablet and interlocking system, has given satisfaction wherever it has been installed.

*For abstract of previous statement see *Railway Engineer*, November, 1904, p. 368.

EDITOR'S NOTICE.—All manuscripts and communications should be distinctly written, or preferably type-written, on one side of the paper only, and addressed to the Editor, **3, Ludgate Circus Buildings, London, E.C.** The Editor cannot undertake to return rejected manuscripts or drawings unless accompanied by a stamped directed envelope.

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The subscription to *The Railway Engineer* is 14s. (payable in advance), post free to any country in the world.

THE
Railway Engineer

VOLUME XXVI., No. 311. *DECEMBER*, 1905.

Contents for December.

Mr. Edward T. Broadhurst, 56, Oxford Street, Manchester, has been elected to fill the vacancy in the Board of the L. and North-Western R. caused by the resignation of **Sir W. H. Houldsworth, Bart., M.P.**

Lieut.-General Sir Richard Strachey, R.E., chairman of the East Indian R., has been awarded the Symons gold medal of the Meteorological Society in recognition of the valuable work he has done in connection with meteorological science. The medal will be presented at the annual general meeting of the Society on the 17th prox.

Mr. Vincent Hill, general manager South-Eastern and Chatham Rs. Managing Committee, has been appointed chairman of the general managers of the railway companies of Great Britain associated with the Railway Clearing House.

Mr. Henry Partington, assistant goods manager L. and North-Western R., has been elected chairman of the Goods Managers Conference for the ensuing year. This is a particular compliment to Mr. Partington, as it is the first time that an "assistant" has ever been elected to fill this position.

Mr. John Martin, who lately succeeded to the appointment of general accountant to the North British R., still retains the secretaryship of the Forth Bridge and West Highland Railway Companies.

Mr. A. Rutherford, the late chief goods manager of the North British R., was at a recent conference of the Clearing House the recipient of a handsome silver canteen service from his colleagues there. Mr. Rutherford has been associated with the Conference deliberations since 1872.

Mr. Henry E. Walker, assistant locomotive superintendent of the Buenos Ayres Western R., has been appointed as from the 1st ultimo locomotive, carriage and wagon superintendent of the Buenos Ayres Great Southern R., in succession to **Mr. Robert Gould,** who retires, and **Mr. A. C. Renton,** late resident engineer Buenos Ayres and Pacific R., has been appointed resident engineer.

Mr. Surrey Warner, assistant carriage and wagon works manager Great Western R., has been appointed carriage and wagon superintendent of the L. and South-Western R., in succession to **Mr. W. Panter,** who, as we stated in a recent issue, retires at the end of the year.

Mr. W. H. Williams, assistant running superintendent Great Western R., has been elected Mayor of Swindon.

Mr. P. Marriott Payne, assistant rating surveyor, has been appointed rating surveyor to the Midland R., in succession to **Mr. W. P. Payne,** who retires at the end of the year.

WE regret to record the death, on the 8th ultimo, of **Mr. Charles Grey Mott,** director of the Great Western R. (since 1868), chairman of the City and South London, the Southern of Peru, the Midland of Uruguay, and several other railways. He was 72 years of age. He was generally referred to as the "father" of electric traction on underground railways, because he was mainly responsible for introducing that system of traction on to the City and South London R., which it was originally intended should be worked hy cable.

*

Proposed Railway Amalgamations.

Great North of Scotland and the Highland Railways.

JUDGING by the published terms of this proposed amalgamation it would perhaps be more correct to say that the former company will take over the undertaking of the latter. But even so it will be a great benefit to the shareholders of both companies, and also to the country served by both lines. One strong company is always better than two weak and partially competing ones. Nevertheless, it is evident that the grumblings are being fanned into thunder in the interests of lawyers, and the scheme of amalgamation promises to be the *pièce de resistance* of the next Parliamentary Session. The Scots are generally a "careful" people, but, by some strange paradox, they seem to revel in that most expensive luxury—law.

Lancashire, Derbyshire and East Coast R.

SUBJECT to Parliament's approval terms have been agreed by which this unfortunate concern will be bought up and absorbed by the Great Central R. It is to be hoped the Bill will be passed, as the acquisition of this railway would greatly benefit both the Great Central R. and the public, while the staff of the L.D. and E.C.R. would be elated beyond description. And by the construction of a short length of line this railway would provide the Great Central R. with a second route for much of its traffic from and to Manchester without its having, as it now does, to pass through the Woodhead Tunnel.

The Waterloo and City and the Axminster and Lyme Regis.

By the Bill deposited by the L. and South-Western R. Co. asks, amongst other things, for powers to take over and absorb the Waterloo and City R. and the Axminster and Lyme Regis. R·

Railway Bookstalls.

At the end of the year Messrs. W. H. Smith and Son's contract for the bookstalls and advertising on the L. and North Western and the Great Western railways expires by effluxion of time, and on the first of January Messrs. Wyman and Sons will take over the bookstalls on both railways, and the advertising on the Great Western R., while the advertising on the L. and North Western R. has been secured by Mr. T. Kershaw, of Manchester. Messrs. W. H. Smith and Son have had the bookstalls for upwards of 50 years and have amassed a huge fortune out of the public through them. The railway companies in these hard times very rightly considered they should have more of these profits, and as Messrs. Smith could not see their way to give more the companies advertised for tenders—as they ought to have done years ago—with the result above stated. The public cannot possibly be worse off and the railway companies will certainly be better off. We believe we are correct in stating that the railway companies have been receiving half the gross receipts from the advertisements in return for finding the space, carrying the advertisements, and assisting in the hanging—an arrangement which says very little for the business acumen of the directors. The North London R. is an exception and has its own advertisement department, much to its own profit we should think; but on this railway also the bookstalls will pass over to Messrs. Wyman and Sons on the 1st proximo.

As Messrs. Smith have announced that they do not intend to leave more of their business to their successors than they can help the development of the change will be watched with interest.

*

Preservation of Steel Cars.

At the Master Car and Locomotive Painters' Convention, held at Cleveland, O., last September, Mr. T. J. Rodabaugh, of the Pennsylvania Co., read a paper on the Preservation of Steel Cars, in which he said he did not think any progress had been made because of the limited privileges that the foreman had for making practical tests of paint. He ridiculed the usual tests of painted plates of metal hung out to dry on roofs and walls, and expressed the opinion that the preservation of steel cars by painting them would never be accomplished until the management gave up the practice of loading "hot slag and taking sledge "hammers on to the outside of a car to loosen the coal and slag "that has frozen in them during the winter."

*

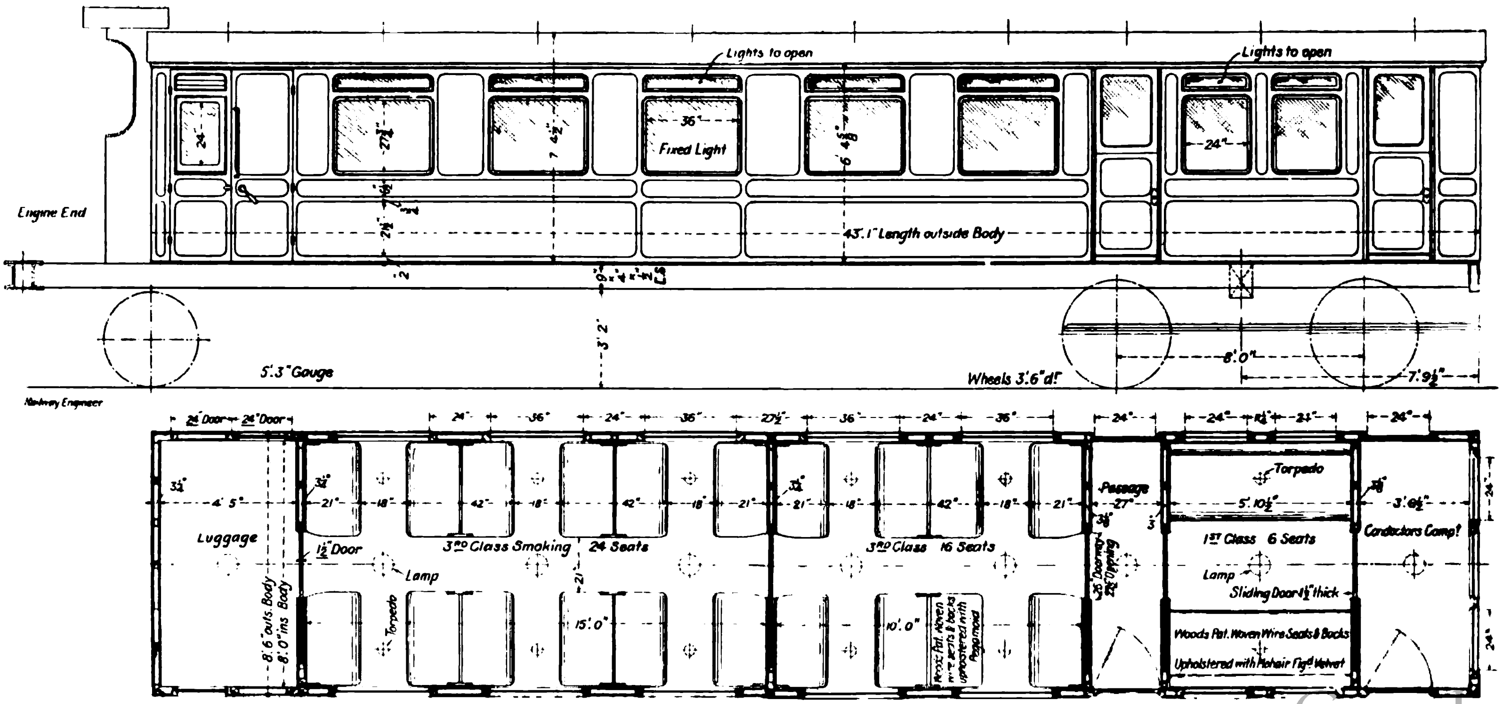
The York Engineering Co.

This concern has lately been wound up by voluntary liquidation, and its shareholders have received a final dividend of 261½ per cent. Its paid-up capital was £70,000, and its assets realised £183,000. In the past its shareholders have received enormous dividends, and the shareholders of the North Eastern R. ought to be delighted to hear that this concern will no longer live on their property. Turning wheels for the N.E.R. was one of its chief lines of business, but the establishment of the Darlington shops and "hard times" spoilt the business.

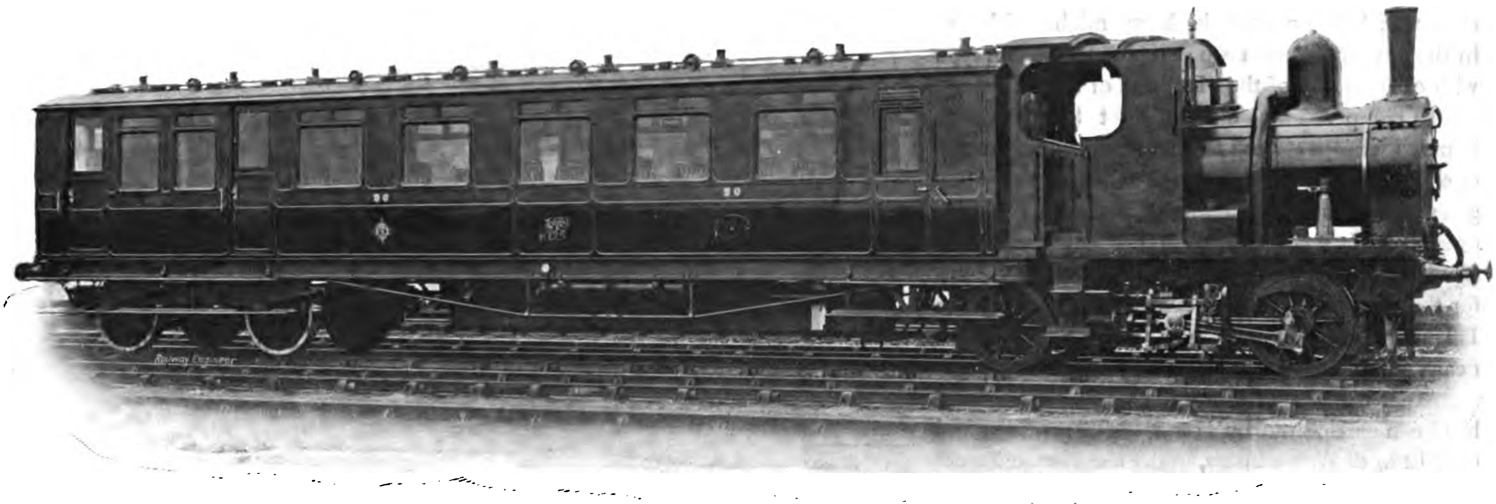
*

The Slowest Train in the World.

M. Georges Irade, writing in the French journal, *Les Sports*, claims that after a long and conscientious search he has run to earth the slowest ordinary passenger train in the world. This record-holder is chronicled on page 773 of the *Guide Chaix*, and performs in Spain, a country in which twelve miles an hour is by no means an uncommon rate of speed on the railway between Soto-de-Rey and Ciano-Santa-Ana. This line is 13¾ miles long, and it has one station *en route*, viz., Sama, which is 12 miles from Soto-de-Rey and 1¾ miles from Ciano-Santa-Ana. Leaving the last-named place at 6.25 a.m. the train reaches Sama at 6.55, and Soto-de-Rey at 8.20. Thus the average rate of speed of the train is under seven miles an hour, while from Ciano-Santa-Ana to Sama the speed is only 3½ miles an hour. At all events, serious railway accidents ought not to be feared by travellers on this line; even if the train ran off the line the consequences would not be startlingly disastrous, and there is always the great advantage of such a train in that if one misses it at Ciano one, if a good walker, can catch it up at Sama.



Steam Rail Cars; Midland Railway (Northern Counties Committee).



Steam Rail Motor Cars, Midland Railway (Northern Counties Committee).

We are indebted to the courtesy of Mr. R. M. Deeley, M.Inst. C.E., locomotive engineer of the Midland R., for the accompanying photograph and particulars of one of the steam rail motor cars recently built at the Derby works for service between Greenisland and Antrim, on the Northern Counties section of the railway.

The carriage portion is divided into 3rd class smoking, 3rd class non-smoking, 1st class, luggage, and driver's compartments.

The 1st class compartment accommodates 6, and the two 3rd class compartments 40 passengers.

The engine is of the locomotive type, with outside cylinders driving the end pair of wheels, which are not coupled to the other pair of the engine bogie. Walschaert's motion is employed for actuating the slide valves, which are above the cylinders.

The following are the leading particulars :—

Cylinders: 9½in. diam. by 15in. stroke.

Boiler: Mean diameter of barrel inside, 3ft. 7½ins.; thickness of plates, ½in.; length of barrel between tube plates, 4ft.; 139 brass tubes, 1¾ins. outside diam.; length of firebox shell, 3ft. 1ins.

Heating surface: Firebox, 51sq. ft.; tubes, 262 sq. ft. Total, 313 sq. ft.

Grate area, 7·6 sq. ft.

Wheelbase: Engine bogie, 10ft.; carriage bogie, 8ft.; centres of bogies, 39ft. 7½ins.

Length over buffers: 60ft. 5¼ins.

Wheels: Engine driving, 3ft. 7¼ins. diam.; engine trailing, 3ft. 3ins. diam.; carriage, 3ft. 6ins. diam.

Water capacity of tank, 500 gallons.

Coal capacity, 11½ cwts.

Weights determined at Belfast :—

	Empty.			*Working.*		
	tons.	cwt.	qr.	tons.	cwt.	qr.
On driving axle ...	14	16	0	16	2	0
On trailing	8	4	0	6	8	2
On carriage bogie ...	12	10	2	13	12	2
Total ...	35	10	2	39	3	0

We are also indebted to Mr. Bowman Malcolm, M.Inst. C.E., locomotive engineer to the Northern Counties Committee, for the diagram and following particulars of the carriage which was constructed to his general specification, though the details were all worked out at Derby, where the vehicles were made.

The body is 43ft. 1in. long by 8ft. wide inside. The inside lengths of the compartments are figured on the drawing. The 3rd class smoking compartment seats 24 passengers, the 3rd class non-smoking 16, and the 1st class 6. All the partitions between the compartments have sliding doors. The vehicles are provided with steam-heating apparatus, and are lighted with ordinary Pintsch gas lamps, opening from the inside.

The upper panels of the 3rd class compartments are of birdseye maple and the lower ones of oak, and the seats upholstered with maroon Pegamoid, while the 1st class is panelled with mahogany and upholstered with old gold-coloured figured velvet, over Wood's woven wire seats, which are also used in the 3rd class compartments.

The gauge is 5ft. 3in.

High Pressure Incandescent Gas Lighting; Broad Street Station, North London Railway.

The great success which has attended the introduction of high pressure incandescent gas lighting for railway stations and other public places was fully demonstrated on the 7th ultimo when Broad Street Station, North London R., was lit up by Messrs. William Sugg and Co.'s system.

Broad Street is now without doubt the most brilliantly lighted

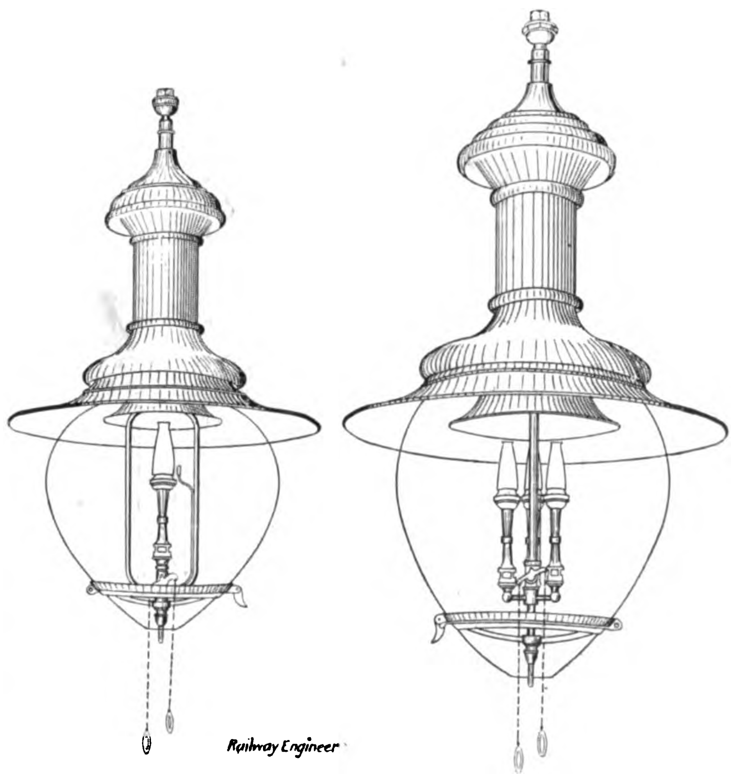


Fig. 1.—Sugg's Newark Lamp. Fig. 2.—Sugg's Belgravia Lamp.
Broad Street Station, North London R.

station in London—we think we might safely say in the country—and it is possible to read small type with ease on any of the platforms or staircases.

As compared with electric light Sugg's system is much cheaper both as to first cost and subsequent maintenance, and for the same annual outlay gives a much superior light which is well diffused, does not flicker, and throws no deep shadows, a fact which, no doubt, helped to secure its adoption for the lighting of the precincts of Buckingham Palace, which installation Messrs. Sugg's have nearly completed and will shortly open.

At Broad Street Station the whole of the work has been carried out by Messrs. William Sugg and Co., Ltd., of Westminster, under the instructions of Mr. Henry J. Pryce, locomotive superintendent of the North London R., and Mr. E. W. Goodenough, chief inspector of the Gas Light and Coke Co.

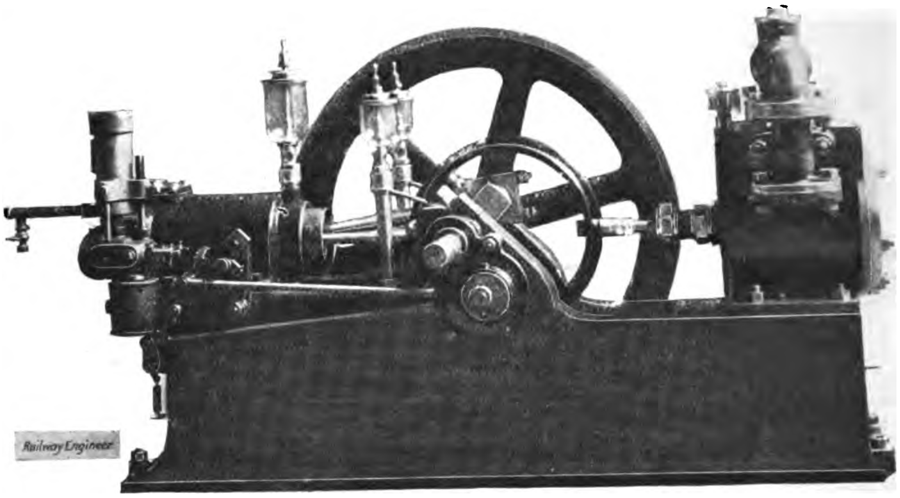


Fig. 3.—Gas Driven Compressor for High Pressure Incandescent Gas Lighting.

The eight platforms are lighted with fifty-nine 300 candle-power "Newark" lamps, fig. 1, or a total of 17,700 candle power with an hourly consumption of 590 cubic feet of gas, which at 2*s.* 11*d.* per 1,000 cubic feet costs only 1*s.* 8½*d.* The carriage approach, five staircases, two arcades and the circulating area leading to the eight platforms are lighted with fifty-one of Sugg's high pressure incandescent lamps having together a total lighting capacity of 17,260 c.p., having an hourly consumption of 576 cubic feet, costing only 1*s.* 8*d.* per hour. The parcels office, cloakroom, booking offices, etc., are lit by low pressure incandescent lamps having an aggregate lighting power equal to that of 5,040 candles and consuming 252 cubic feet, costing 8¾*d.* The lamps are "regenerative," and are very strong, the globe being supported from the bottom by means of the central rod so that should they break there is little risk of them falling.

Broad Street Station is very happily situated, as it is able to obtain its gas supply at a pressure of 10ins. direct from the Gas Light and Coke Co.'s high pressure trunk main. But this is not a very important point, as Messrs. Sugg make a very compact gas-driven compressor, fig. 3, which requires but little attention. The size illustrated occupies a space 34ins. long by 15ins. by 23ins. high, and is capable of dealing with the gas required by eighty 1,000 c.p. lamps of the "Belgravia" type, fig. 2, of which two are fixed in each arcade of Broad Street Station.

This station was lighted by old-fashioned gas burners, and before Sugg's system was adopted the subject was thoroughly investigated and carefully compared with electric light, but though the company was offered electric current at 1¼*d.* per unit it was decided to instal a modern system of gas lighting—a decision no doubt influenced by the fact that at Victoria Station

Fig. 4.—View of Interior of Broad Street Station, N.L.R. Photograph taken by Sugg's High Pressure Incandescent Gas Light

the L., Brighton and South Coast R. Co. have saved more than £1,000 per annum by substituting good gas lighting for indifferent electric lighting.

It is a striking fact, and one that illustrates the veritable revolution effected in gas lighting by the invention of the incandescent mantle, that, although the lighting of Broad Street Station has been *increased* from a total of 8,000 to 40,000 candles, it is estimated that the gas bill will be *reduced* by over £200 a year, after providing for the cost of all mantles, attendance, &c.

For the lighting of workshops this system is admirably suited, and it would be difficult to find better lighted works than Messrs. Sugg's at Regency Street, Westminster. These works cover about an acre, and works managers not familiar with this system of lighting would find a visit to them full of interest.

Fig. 4 is a photographic view of the station, and its sharpness of detail illustrates the quality of the lighting. The apparently deserted condition of the station is explained by the length of exposure, about 20 minutes, given to the plates.

Books, Papers and Pamphlets.

The Merchantable Timbers of Queensland. REPORT BY PHILIP MACMAHON. Brisbane: Geo. A. Vaughan, Government Printer. 1905.

THIS is a report by the Director of the Government Botanic Gardens, Brisbane, issued under the authority of the Hon. Digby F. Denham, M.L.A., Secretary for Agriculture of Queensland. Its object is to bring prominently before users of timber generally, and railway engineers (especially in tropical countries) in particular, the merits and properties of Queensland timbers.

The report has been compiled with great care, and no pains have been spared in either its preparation or production. It is exhaustive and instructive, and, while the nature and habits of the trees are treated of scientifically, the practical and commercial features, such as strength, weight, size, price and uses, always predominate.

There are 60 large photographic illustrations of the growth, felling, scantlings and use of Queensland timbers. Some of these show sections through the spike holes or views of the rail seats of sleepers after having been in use 14 years, and which are interesting, as they show that the sleepers were still sound and that the sleepers were only "weathered" at the edges; the wood itself being, it is stated, harder than when it was first laid in the road. For the purposes of contrast, illustrations are given of similar sections of sleepers lifted from American railways after only one or two years service. Another illustration of a sharp curve shows that rails on sleepers of Queensland timber only require single spiking as when laid on the straight.

There are also two large coloured maps of the forest belts and several smaller ones showing the elevations, rainfall, etc.

All the carriages and wagons of the Queensland railways are built at the new works at Ipswich, entirely of native timber, which is delivered in logs and converted at the works. The timbers which are used for the various parts of the vehicles are specified and some valuable remarks and opinions by Mr. Horniblow, chief mechanical engineer, are quoted, and amongst which we notice that Silkwood or Cardwell Maple is quite equal to teak.

Among the several tables is one giving the characteristics of eight timbers now exported for sleepers, viz., the percentage of moisture, dry material and ash and the distinguishing characters of the sawdust, ash and sections. Another useful table is one of 100 Queensland timbers and the purposes for which they are suitable.

*

Standard Steel Construction. COMPILED FOR HALL AND PICKLES BY CHAS. HEATHCOTE AND SONS 2nd Edition. London: Sherratt and Hughes, 65, Long Acre, W.C.; Manchester: 27, St. Ann Street. 1905.

THESE tables were first compiled for the use of architects, engineers and others engaged in the design of constructional steel work. They have been so largely appreciated that a second edition of them has been issued, and the opportunity has been seized to add some new and valuable features.

The tables are grouped into four sections:—

Property Tables or all sections of angles, Z and T bars, channels, bulbs, built girders and stanchions.

Beam Tables for angles, T and Z bars, channels, joists, compound and plate girders. These give the safe uniform load for all sizes up to 25ft. span for the small sections and 50ft. for the larger ones, advancing by 1 and 2ft. respectively.

Strut Tables for single and coupled angles and tees, rolled joists and compound sections and cast-iron columns.

Table of Beam-loading Factors to reduce an irregular load to an equivalent uniformly distributed load.

There are also two very useful plates, one showing the shearing strength of girder webs and the other the economical values of various types of stanchions.

Considerable space is given to the consideration of eccentric loading and the method of using the tables to ascertain the sections necessary, *e.g.*, when beams are supported on angle brackets riveted on to the flange of a stanchion or when floor joists are carried on a bracket angle riveted on to the web of a girder.

Such tables must be well-nigh invaluable, particularly when, as in the case with these, they are printed in large clear type. We have not, of course, checked these tables, except in two or three places, and these we found were correct.

*

Books Received.

Reference Book for Statical Calculations. By FRANCIS RUFF. With 160 illustrations. London: E. and F. N. Spon, Ltd., 57, Haymarket. 1905. [136pp.; 7¾ins. by 5ins.]

Fowler's Mechanical Engineer's Pocket Book, 1906. Edited by Wm. H. Fowler. Scientific Publishing Co., Manchester. [516pp. 6 ins. by 3¾ins.; price, 1*s.* 6*d.* net.]

The Use and Care of Chains for Lifting and Hauling. By HENRY ADAMS. 2nd Edition. London: 60, Queen Victoria Street, E.C. [21pp. price, 1*s.*]

This is a reprint of a paper read before the Civil and Mechanical Engineers' Society, and is, we believe, the only book or paper dealing with the subject. The author has had a lengthy practical experience with dock machinery and cranes, and was recently called in to advise the Home Office authorities when they were preparing their Regulations for Docks and Wharves.

Rail-Motor Carriages; L. & North Western Railway.

IN our October issue we illustrated the new Rail-Motor Carriages which have lately been put into service on the L. and North Western R., and it will be remembered that one of the distinctive features of these vehicles is that though the carriage body encloses the boiler it is only connected to the engine bogie by

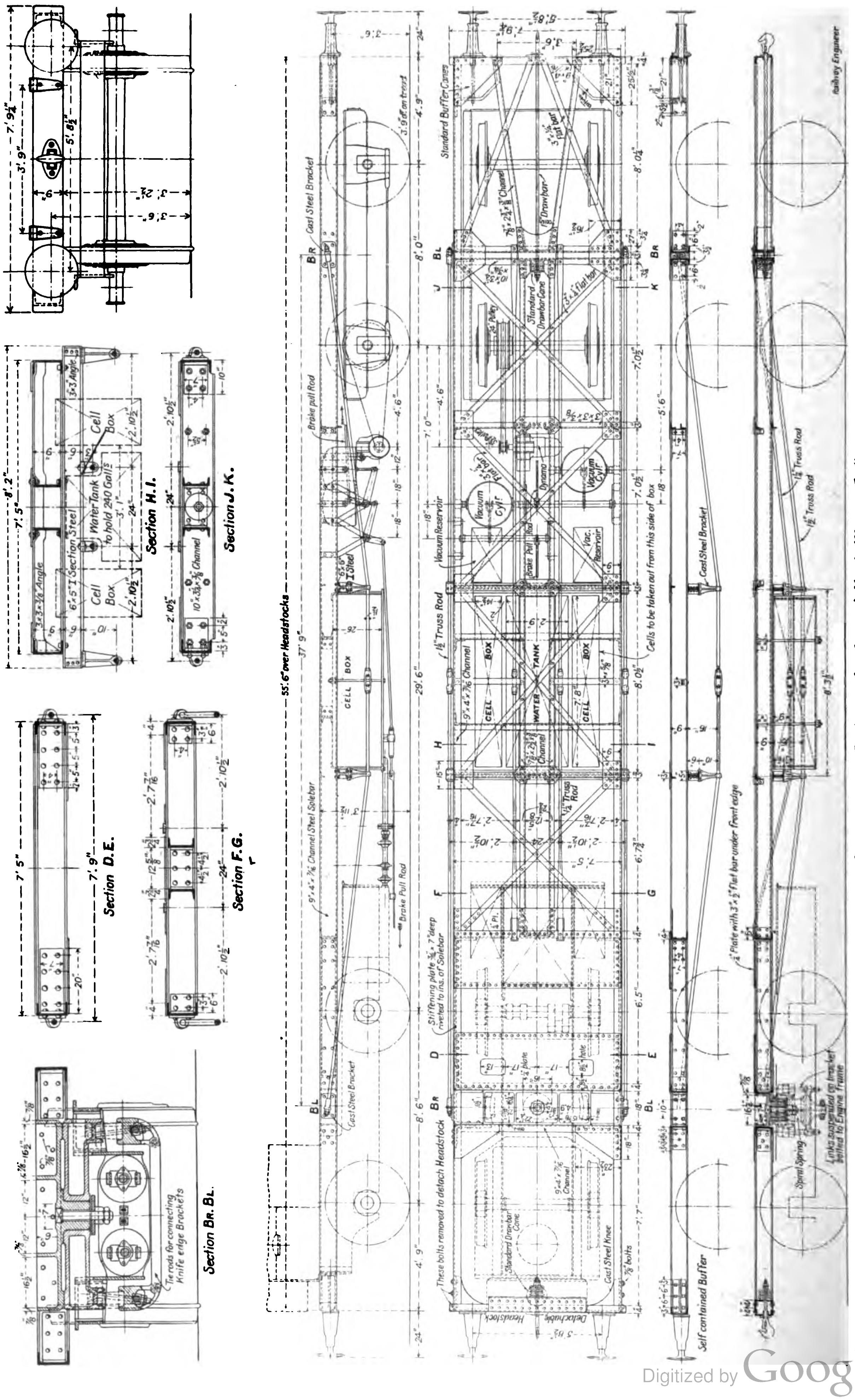
the centre, and on being lifted the boiler is drawn out on the engine bogie through large end doors. There are, of course, some pipes and gearing to disconnect, and the underframe is specially constructed at one end.

By the courtesy of Mr. C. A. Park, M.Inst.C.E., carriage superintendent, we are able to publish a complete drawing of the underframe which he designed to enable the above mentioned operation to be readily carried out.

It will be seen that the headstock, with self-contained buffers, is provided with strong cast-steel knees, which are bolted to the sole bars with six ⅞in. bolts on each side.

The sole bars are stiffened and carry a steel casting forming the bogie centre, and which rests on the swing bolster of the engine bogie as shown at section Br Bl. The other part of the underframe does not differ very materially from the standard practice for L. and N.W. carriages. The drawing is fully dimensioned.

Provision is also made for removing the end portion of the floor of the body when taking out the boiler and engine. This is effected by removing a wrought iron plate which spans across the opening, and which is bolted to the floor bottom sides, and which is provided with an angle iron sill for the end doors to close on.



Underframe for Rail Motor Carriages; London and North Western Railway.

The Erection of Bridges.—I.

INTRODUCTORY.

WHENEVER a bridge has to be built, no matter of what span or design, the importance of the method by which it is to be placed in its intended position is in most cases as vital as is the method on which it is designed. It requires quite as much engineering ability to arrange for the erection as for the construction in the shops of any structure of even small and insignificant dimensions, and in the case of large constructions the question of how the work is to be erected is of the most supreme importance.

The design of ordinary and even of very large bridges is taught in many text books, and is dealt with in many colleges, but it appears from the rarity of monographs upon the subject that the erection, under the many diverse conditions that inevitably arise, is assumed to be a matter that can be undertaken by experience alone, and cannot be imparted in the class room of an engineering college.

It may almost be said that there is literature enough to make the student perfectly certain that he has made no mistake in his thinking out the anatomy and the economical disposition of the diverse parts of his structure, but he is practically told to "go and see" if he enquires how the many parts of his creation are to be put to do their actual work.

And yet it is surely as important that the student shall know how to lift and place his work as it is that he shall learn how many rivets will effectually cover a certain and essential joint.

As a matter of finance alone the erection on site in many cases is as costly as is the material itself, even when it has come out of the shops as completed work, and unless these matters are thoroughly considered beforehand much waste of money may, and probably will, occur.

There are many items to be considered in every case that comes under the care of the bridge engineer. The carriage or transit of the work from the place of manufacture to the site, the climatic influences upon which all outdoor work must depend, the condition and cost of labour, the facility and practicability of oversight, and, more than all, the method and cost of future maintenance, are all points of great and imperative importance, and without a sufficient settlement of each it may be that an insuperable obstacle will be found to the erection of the work and the eventual completion of the scheme.

The question of the erection of the work on site is therefore essentially a "part and parcel" of the design as a whole. The means whereby the putting together of the various parts is to be accomplished should be dealt with simultaneously with the designing of the completed structure, or, more correctly speaking, as an essential factor in the design, and thus it may be easily argued that the erection becomes of equal importance to the economic purpose of the completed work.

The necessity for the consideration of temporary works is fully recognised and invariably dealt with in the choice of the position of a tunnel or the site of a railway station; each description of strata, with its freedom or otherwise from water or quick sands and other obstacles, must be taken into account before the centre line is decided upon, and it is quite as necessary to provide for obstacles or difficulties in the case of bridges of even moderate span.

It may be that the exigencies of the situation demand great rapidity in the execution of the work; the permissible time may be short, as in the time of dry seasons in tropical countries. The presence of malaria may make quick erection essential, and the rains may cause shallow dry rivers to become raging torrents that would carry out to sea, or at least effectively destroy, any scaffolding and trestling that might lie in their course. A delay of a few weeks, or even of months, may not be an exceedingly important matter in the building of a large bridge in temperate zones, but in such conditions as those just indicated such a delay may result in the total demolition of the structure. It has been no uncommon thing in India for such a flood to arise in one day, and Kipling, in "The Bridge Builders," is certainly not beside the mark in this respect.

The road, or the railway, that the bridge is to carry may not at all unlikely form of itself the only access to the parts of the country that lie beyond the bridge, and then until the road is carried over all further progress is at an end. Nay, even the very advance of civilisation itself may depend upon the celerity with which the structure in question may be erected.

Nothing, in these conditions, should then be left to chance; nothing should occur that has not already been foreseen. If malaria and tropical diseases have to be feared the time and dates of their occurrence should be accurately known, and if the danger is one of flood and swollen rivers the season and probable occurrence of these also should be known and the information filed, docketed, and diagrammed in some accurate manner.

The safety of the workmen should also be fully provided for; nets of ample strength and size should be fixed under points of danger, and handrails and protection must be carefully maintained. It is hard to say how far the safety of men should be taken into account in the actual design of a structure, and to what precise extent it should influence the decision whether building out or scaffolding should be adopted, but in any case the point should be considered with all its bearings on the labour that is available on the ground. It would, of course, be impossible to take a ship load of sailors trained to work at dizzy heights into the middle of Equatorial Africa, and it would be equally futile to try to make the natives of certain countries work underneath the ground and go to their work by means of air locks into the compressed air of river caissons.

The cheapness of the proposed method of erection, whatever it may be, is also deserving of careful thought. The designing of the bridge upon the pin system of American engineers may be much more economical as regards labour on site than is the English system of riveted and rigid joints. If the bridge is to be built in Central Africa, where the climate is so unhealthy to Europeans that the work must be done as quickly as possible, pins at the joints or articulations may much expedite the work and save the cost of special gangs of English riveters.

In such a situation it may not be necessary to send out from home expensive and costly plant, cranes, and tackle. Labour may be cheap and plentiful, and it may be better to employ a chain of natives to carry on their heads the material that is to be used than it would be to send out the most ingenuously and elaborately contrived cable tram from England.

In many cases timber may be plentiful, and even may have to be cut down to allow the road or line to pass through it

and this may point to scaffolding being much to be preferred to building out or floating out, however certain it is that the latter methods of erection would be used nearer home.

There are a number of well-known cases in Russia where girders in pieces have been carried several hundreds of miles in railway trucks, the same trucks being afterwards used as a stage upon which the whole structure was put together after arrival at the site. In these cases the complete bridge is pulled over the opening upon a temporary bridge or staging and placed on temporary bearings. The railway trucks are then hauled away and the bridge lowered into its permanent position.

It may perhaps be correct to say that it is practicable to design the erection of any bridge, of whatever design, so that it can be built without any scaffolding at all, but of course to follow this as an unalterable rule in all cases would be absurd to the last degree. It is certain, however, that very diverse methods of erection may be merged into one another with great success in many cases, where, for example, it is found economical to half roll over a girder until it can be placed upon a floating barge and the work then completed by water haulage. In all such cases, however, where two dissimilar systems are blended together, it will probably be found that much greater care, much better weather, far more complicated arrangements must be made than where one system of erection alone is adopted in its entirety.

When a large bridge has to be erected in a foreign country it is very probable that the best system of building will not be evolved in anything like detail until the engineer arrives on the ground and studies the problem with the actual facts before him. He may, as a matter of fact, have depended upon an unlimited supply of labour where natives may be exceedingly scarce, or he may have anticipated the free use of timber where the trees are suitable for anything but the work that has to be done.

It goes almost without saying that where joints in iron bridges have to be riveted together with their essential covers on the site, they should be most carefully and specially designed. If the material has to be loaded into the holds of ships and lifted out again it is obvious that light, long and thin bars will be very liable to damage, and if this injury is discovered only when the injured piece arrives at its destination far away from home, the consequences may be serious and much anxiety and delay involved. In all cases the different parts of the work should be painted different colours, say red, green and white, for different parts of the structure, base, uprights and top, and the marking of all the parts should be thorough and complete.

Sometimes, then, it is one consideration, sometimes another, that guides the method of the work on site, but it is surely possible to employ one ideal in nearly all examples, and that is elegance of method and gracefulness of the whole operation.

In the following papers the different classes of bridge erections will be taken under the following heads, viz. :—

A. Girders, by lifting in one piece.
B. Girders, by erection on staging.
C. Girders, by moving bodily sideways.
D. Girders, by floating out on pontoons.
E. Girders, by protrusion of temporary work.
F. Continuous girders, generally.
G. Continuous girders, by rolling out from the end.
H. Cantilevers, by building out from abutments.
I. Metal arches, by building out from abutments.
J. Miscellaneous.

A. Girders, by Lifting in One Piece.

This appears at first observation to be the simplest and most obvious method by which girders for bridges may be erected, and if the girder is not too long or too heavy for the available lifting power, much anxiety may be saved by the adoption of this method.

Of course the point of application of the lifting power must be carefully considered, as it is not frequently the case that the chains or sling of the crane can be applied underneath the actual permanent bearings of the girder, and practically always the lifting has to be done at a point intermediate in the span where there may not be either a suitable bearing plate under the girder or stiffeners between the two flanges to prevent their crippling and local injury.

If the girder is lifted in the centre of its length the result is that every bar is stressed by the weight of the girder in a contrary direction to what it will have been designed, and even if the lifting is done from two points nearer the ends the outer extremities of the length are stressed as cantilevers. Local damage to the ironwork may ensue, such as the bending up of the sides of the flange, the tearing out of rivets, and even the splitting of the plates and angles. These local damages are extremely difficult to make good, and in any case, even if the damage can be remedied, the metal will have been strained at this part, and it is very questionable whether its elasticity and resilience can be regained.

If girders are carried to their destination on railway wagons the handling of them in the lifting on and off the vehicles, and the sources of possible damage during transit all require to be previously provided for. The girders may easily be strained by the lifting and may be also damaged by the loading of them on their sides, in the flat position, instead of propping them from the sides of the wagon in a position where the webs of the girders are vertical. The loaded wagons will have to travel around curves on the line, and at the junction with the maker's works these curves may be of considerable sharpness. In this case, of course, the wheels of the vehicle will have to follow the curves of the rails whatever that may be, whilst the girder itself will either remain straight or be severely damaged. On the journey shunting, sudden stops, or brakeing will occur, and the girder will have to sustain heavy end blows and at its temporary bearings will have to bear friction with the wagon or bolster, together with the occasional jerk of the steadying chains, which is inevitable.

Much better and more satisfactory work will, however, be ensured in any case if the riveting up of the girders is done entirely at the maker's works than would be the case where some of the joints, with their covers, are riveted up on the site. Even when good staging is provided for the riveting gangs, and where machine riveting is employed, the work cannot be quite as good and tight as in the maker's yard.

The following cases of the lifting of girders in one piece may be cited as examples.

St. Pinnock Viaduct.—This is a case of the renewal of an old timber structure by means of new iron girders (see fig. 1).

The work of erection was novel in character. The upper part of the piers of the old structure had been originally constructed of timber, and it was necessary for the reception of

the new iron girders that this upper portion of the pier should be reconstructed in stone, it also being necessary to make provision for the running of trains over the viaduct during the whole of the time that the work of renewal was in progress.

It is said that this manner of renewing old viaducts is economical only in the case of those over 120ft. in height, and that in cases where the height is less it is better to reconstruct the viaduct entirely of brick or stone. As a matter of fact, the renewal in question cost only about one-half of what the rebuilding in stone would have cost.

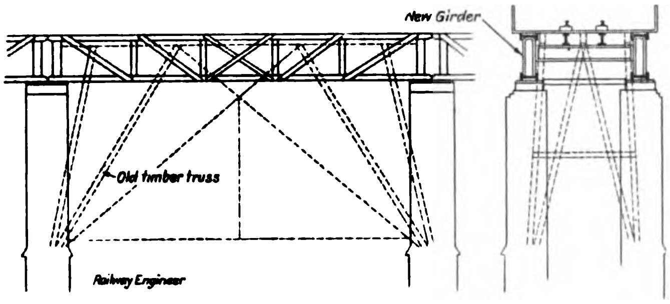


Fig. 1.

Much interlacing of old and new work had to be done in this case. The struts under the centre beams were shifted sideways on the piers so that masonry could be built outside them, an indication of which is given in the figure. Some of the diagonal bracing was removed at the same time, and room was left inside the new masonry in order that the timber struts could be removed when the new girders were erected.

An arch was built in the centre of the new upper part of the pier, in order that the masonry could be built to its full height without pulling down the timber struts which supported the railway above.

A temporary road of ordinary gauge was carried out on cantilevers on each side of the old viaduct, and at the same level as the running lines, and these two lines were used to carry most of the materials for the new work by means of light travelling cranes.

The new main girders, each weighing 15 tons, were carried to their destination by a couple of 10-ton cranes working on the main line. The time occupied in the fetching of two girders from a siding near the viaduct, the hauling of them to their place, the lowering on to the bed stones, and the running back of the two cranes to the siding was in some cases less than an hour.

The cross girders were threaded into their place between the timbers of the old viaduct, partly by cranes and partly by Weston's blocks.

The replacing of the timber floor by Barlow rail decking, in lengths of about 10ft., completed the work.

(To be continued.)

High-speed Steel for Drilling.

High-speed, or what is known as air-hardening, steel has within a few years completely revolutionised machine shop practice. Cutting speeds have been trebled and the output more than doubled. Until recently it has not, however, been successfully used for drilling purposes. The principal reason for this has been that manufacturers of twist drills seemed unable to furnish a drill of this material and guarantee its reliability. Also the percentage of loss in manufacture which occurs with steel of this nature is so great that the price to the purchaser would naturally be increased to such an extent that the advantages would be overshadowed.*

The Rich flat drill bit has recently been placed on the market and is the first successful application of high-speed steel for drilling purposes. Various trials have demonstrated that one of these drill bits outwear 10 to 15 twist drills, and each is absolutely guaranteed by the manufacturer, so that the buyer is called upon to take no risk whatever.

The form of the flat bit is shown in the illustration. Its construction is simple, but it is extremely efficient and embodies many strong features. It is made of a rolled bar of carefully selected air-hardening steel. Suitable lengths are then cut and put through a highly refined process—the result of long and costly experiments. They are carefully tempered throughout the entire length, for they are designed to be usable up to within two inches of the butt. They are next ground and are then ready for use. During the process of manufacture frequent tests are made, and any showing the slightest defect are thrown out.

Some interesting trials have been made which indicate the superiority of air-hardening steel for drilling purposes, and show the remarkable endurance which it exhibits in this class of work. At one of the Carnegie Steel Company's rail mills a set of six Rich flat drills each drilled 1,600 holes 1in. diam. in 80lb. steel rails without being reground. Fifty holes with the ordinary twist bit would be considered a very good performance.

Fig. 1.—Rich Flat Drill Bit.

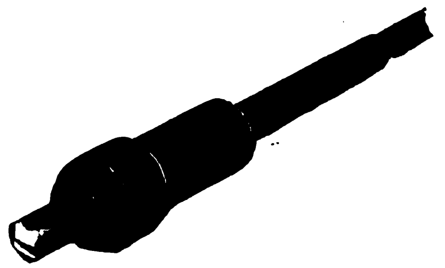


Fig. 2.—Spindle for Rich Flat Bit.

That a great deal depends on the proper tempering and refining of air-hardening steel in the production of a drill bit was made evident by a test conducted at the mill of the Illinois Steel Company at South Chicago, where the Rich drill was tested with forged flat drills of the same material, where it was found that the Rich bit drilled twice as many holes at 50 per cent. greater speed.

Another interesting experiment was made on armour plate in the Navy Yard at New York. The Rich drill bit drilled 10 holes in the armour plate turrets of the battleship "Connecticut" 1¼ins. diam. without re-sharpening, whilst eight twist drills were used without finishing one hole. These and other tests convincingly indicate the ability of air-hardening steel, as developed in the Rich flat bit, to withstand the severest service under high-speed conditions with coarse feeds. The extreme hardness of these drills and the conse-

* One of the causes of the comparative failure of "high-speed" drilling in this country is the fact that the men cannot be depended upon to slack off the feed when the material at the bottom of the hole is getting thin, with the result that the enormous pressure necessary to force the point of the drill into the work pushes the drill through the thin bottom and generally breaks it.—Ed. *R.E.*

quent economy ensuing from their use will doubtless augment their use for track work.

The shape of the Rich flat drill is such that a special chuck is made necessary. This is furnished by the same company and is an excellent example of the machinist's art, being considerably above the average. The jaws, which are adjustable, are so arranged that the bit is held dead true and absolutely firm by means of a clamping unit. The end of the bit is supported by an adjustable thrust block within the barrel, which may be changed to compensate for the wearing off of the point in grinding. One important feature which reduces the liability of the drill breaking is the depth of the barrel, which allows the bit to recede into it until only enough is presented to penetrate the work before it.—*The Railway and Engineering Review.*

Modern British Locomotive Construction.

By Chas. S. Lake.

It is of great importance that modern locomotives should combine the ability to run at high speeds with an abundant hauling capacity, but of the two qualifications the latter must always receive first consideration where the work to be performed is of a maximum character. To this reason may be ascribed the tendency to increase the size of the boilers, whilst restricting the proportions of the cylinders and wheels, the more general employment of high steam pressures, and the wider use of compound cylinders. There is also a more clearly defined inclination to enquire into the possibilities of superheated steam, and on another British railway this system will in the near future be tried.

There would appear to be ample reason for extending the use of three or four cylinder compound locomotives, which, by bringing into operation a starting or "change" valve, can be worked as "simple" engines of great power for temporary purposes, such as at starting or on steep gradients with heavy train loads.

Locomotives constructed on this principle ought to be more economical than those in which multiple cylinders adapted for using steam direct from the boiler are employed. In the latter class the range of expansion is no greater than in a two cylinder simple engine, but the four small cylinders are more convenient of disposition than two of a diameter giving the same capacity can be, and the piston effort is distributed over four cranks instead of two, thus rendering the engine more reliable at starting with maximum loads, whilst by arranging the cylinders in pairs to drive separate axles a distribution of the stresses is brought about through being divided over two axles instead of concentrated in one, as would of necessity be the case if only the two cylinders were employed. Nevertheless it is difficult to appreciate the reasons for the adoption of the four-cylinder simple engine, which is the type most likely to be wasteful in steam consumption.

In the last issue of the *Railway Engineer* there appeared an illustrated description of one of a series of four-cylinder locomotives designed by Mr. D. Drummond for hauling the heaviest passenger trains on the most difficult sections of the L. and South Western R. These engines have cylinders 16ins. dia. by 24ins. stroke and three pairs of wheels coupled 6ft. in diameter, and upon which the total load is 51½ tons. The boiler has a total heating surface of 2,727 sq. ft., including that contained in a group of cross water tubes in the firebox. The working pressure is 175lbs. per sq. in. and the grate area 31½ sq. ft. Thus every feature necessary to the development of extreme hauling capacity is present in the design; the engines should and will doubtless prove themselves to be equal to the task of dealing single-handed with the biggest loads that can be accommodated at the stations and even then possess a reserve of power which would only be required under the most unfavourable conditions of service. In spite of this, however, it is not easy to understand why the designer should prefer to adopt the high-pressure method of working rather than to resort to compounding.

In two-cylinder simple locomotives it is possible to secure a wider range of expansion than is usual on this type by employing a long piston stroke in cylinders of relatively small diameter. Mr. Patrick Stirling did this in his famous 8ft. "single" locomotives on the Great Northern R., and lately Mr. G. J. Churchward has adopted the same plan (in a more accentuated form) on the Great Western R.

Every inch added to the length of the stroke means a corresponding increase in piston-speed, and although it is easy to follow the late Mr. Stirling's object in adopting a 28in. stroke, in conjunction with single driving wheels of such a large diameter as 8ft., the advantage of employing one of 30ins. with coupled wheels of 6ft. 8ins. in locomotives intended for high speed is not by any means so apparent, though of course the pressures adopted by Mr. Churchward are much higher.

Turning from the subject of cylinders to that of wheel arrangements, we find that on British railways in the most recent practice there is a marked tendency to relinquish the 4-4-0 type of engine for those of the Atlantic and 4-6-0 types. This does not alter the fact that the 4-4-0 wheel arrangement possesses advantages of an undeniable character, and it will doubtless continue to enjoy a wide amount of popularity among British engineers. The Atlantic or 4-4-2 arrangement, on the other hand, admits of possibilities in designing the boiler and firebox, which are rendered impracticable in the eight-wheeled four-coupled type of engine owing to the presence in the latter case of a coupled axle at the rear of the firebox. This is so important that many engineers are now prepared to adopt the more extended wheel plan in order to secure freedom for the adoption of larger fireboxes and grates which have become a necessity in modern locomotives of the largest types. The 4-6-0 type of engine may almost be considered as indispensable where traffic has to be worked over sections of a railway abounding in grades of more than usual severity. By the use of three coupled axles a greatly enhanced adhesion weight becomes available without imposing too great a load upon any one individual axle, and as a further consequence of this a cylinder capacity may be employed with advantage which would be altogether excessive in a four wheels coupled locomotive.

It is difficult to forecast what developments may take place in British locomotive practice in the future. If American standards in the matter of wheel arrangement are to be followed there are many which remain to be tried. Extension of wheel base necessitates increasing the length of the boiler, and this should be accompanied by enlargement in the diameter of the barrel, the axis of which would then have to be

pitched correspondingly higher above the rails than at present —a somewhat difficult matter in this country.

All things considered, it seems reasonably clear that the best type of locomotive which can be employed for working express passenger traffic on British railways is the three or four cylinder compound, with the 4-4-2 wheel arrangement, cylinders driving different axles and designed for working either single or compound, and equal when operated single-expansion to two of 20ins. or 21ins. by 26ins.; the boiler as large as can be arranged for in the matter of diameter; moderation in the length of the tubes and firebox; a heating surface as near to 3,000 sq. ft. as can be obtained; a minimum grate area of 30 sq. ft. and a working pressure of 200lbs. per sq. in. with a safety valve area in proportion. Prolonged and careful study of the conditions obtaining in modern railway operation, and frequent opportunities of observing the work performed by locomotives from the footplate, have convinced the writer that an engine designed on the lines indicated would have at least equal chances of success to any at present in service.

Recent issues of the *Railway Engineer* have contained photographic reproductions of some of the latest locomotive types introduced on the leading British railways, and by the courtesy of the locomotive engineers concerned others of equally recent date are illustrated herewith.

Fig. 1 illustrates one of a new series of 4-4-0 type express locomotives designed by Mr. R. M. Deeley, locomotive superintendent of the Midland R. The engine resembles the passenger locomotives, with Belpaire fireboxes, put into service by Mr. S. W. Johnson shortly prior to his retirement, but the working pressure of Mr. Deeley's engines is 200lbs. as compared with the 180lbs. of their predecessors, and for the drum-head tube-plate at the smoke-box end a plate of the ordinary pattern has been substituted.

The smoke-box door is secured by means of six equally spaced dogs, instead of by the ordinary method, with a centre fastening, and it is claimed for the plan that by its adoption the door is kept tighter, thus minimising the risk of drawing air, and thereby partially destroying the vacuum in the smoke-box, whilst reducing the steam generating power of the boiler.

The design of the cab is a great improvement upon anything previously used on Midland passenger locomotives. The roof entirely covers the footplate, and extends backward over the front portion of the tender, whilst the side sheets are also deeper than those fitted to the cabs of previous engines on this line. The tender is of the six-wheeled type, and upon its sides the engine's number is painted in extra large figures, after the style adopted on American railways.

The leading particulars of the new engines are as follows: Cylinders, 19½ins. diam. by 26ins. stroke.

Wheels (coupled), 6ft. 9ins. diam.; bogie, 3ft. 3½ins. diam.

Boiler, centre line above rails, 8ft. 3ins.; diameter of barrel (inside), 4ft. 8ins.; length of barrel, 11ft.

Firebox shell, 8ft. long.

Grate area, 25 sq. ft.

Heating surface—firebox, 145 sq. ft.; tubes, 1,310·5 sq. ft.; total, 1,455·5 sq. ft.

Working steam pressure, 200lbs. per sq. in.

Wheel base, rigid, 9ft. 6ins.

Total (of engine), 23ft. 5½ins.

The engine without its tender weighs 53 tons 10 cwts. 2 qrs. loaded, of which 35 tons 9 cwts. 3 qrs. is on the coupled wheels. The tender is fitted with water pick up apparatus, has a water capacity of 3,500 gallons and weighs 41 tons 8 cwts. 3 qrs. loaded. The total weight of engine and tender in working order is 94 tons 19 cwts. 1 qr.

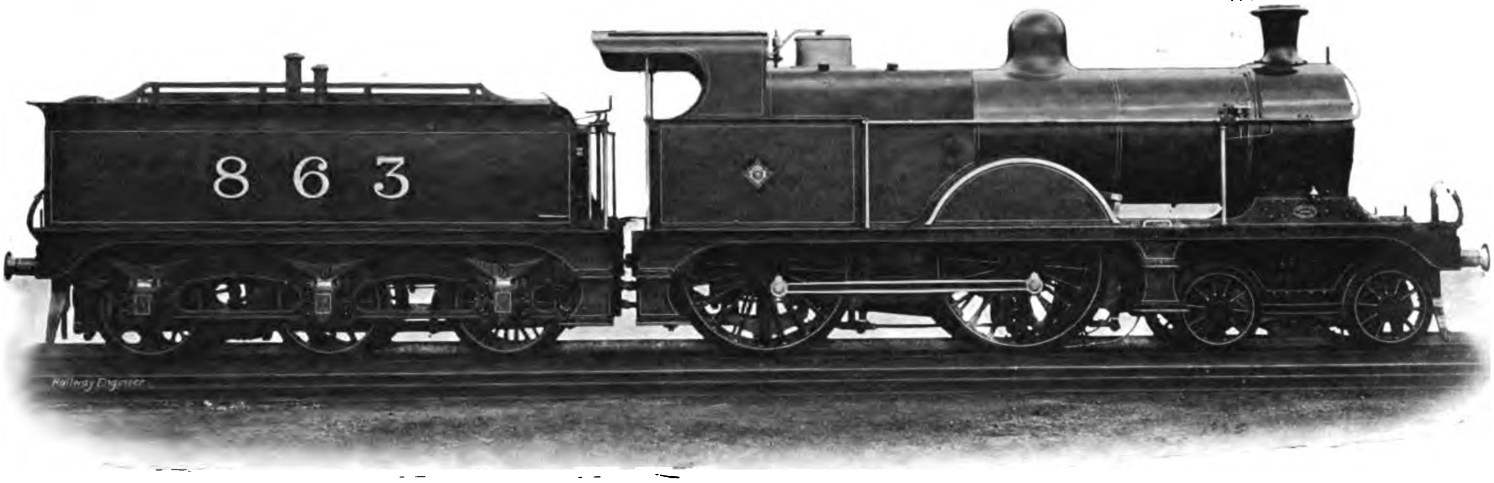


Fig. 1. 4—4—0 Type Express Engine; Midland Railway.

Figs. 2 and 3 represent one of the new de Glehn system four cylinder compounds recently introduced on the Great Western R. This engine is amongst the handsomest locomotives running on a British railway.

The principal dimensions are as follows: — Cylinders, h.p., $14\frac{3}{16}$ diam. by $25\frac{3}{16}$ins. stroke. Cylinders, l.p., 23⅝ins. diam. by $25\frac{3}{16}$ins. stroke. Wheels, bogie, 3ft. 2ins. diam. Coupled, 6ft. 8½ins. diam. Trailing, 4ft. 7⅞ins. diam. Trailing bogie axle to front driving axle, 5ft. 8⅞ins. Centre to centre of coupled axles, 7ft. 0⅝ins. Trailing driving to trailing axle, 8ft. $2\frac{7}{16}$ins. Total wheel base, 28ft. 6½ins. Total length over buffers, 38ft. 8⅜ins. Boiler, total heating surface, 2,616·8 sq. ft. Grate area, 33·9 sq. ft. Height of centre line above rails, 8ft. $10\frac{5}{16}$ins. Working pressure, 227lbs. per sq. in.

The engine weighs 73 tons 6 cwt. in working order, of which 39 tons is available for adhesion.

Among the most recent tank locomotives introduced on British railways are those illustrated in figs. 4 and 5. The first of these is a large 4-4-2 type engine designed by Mr. G.

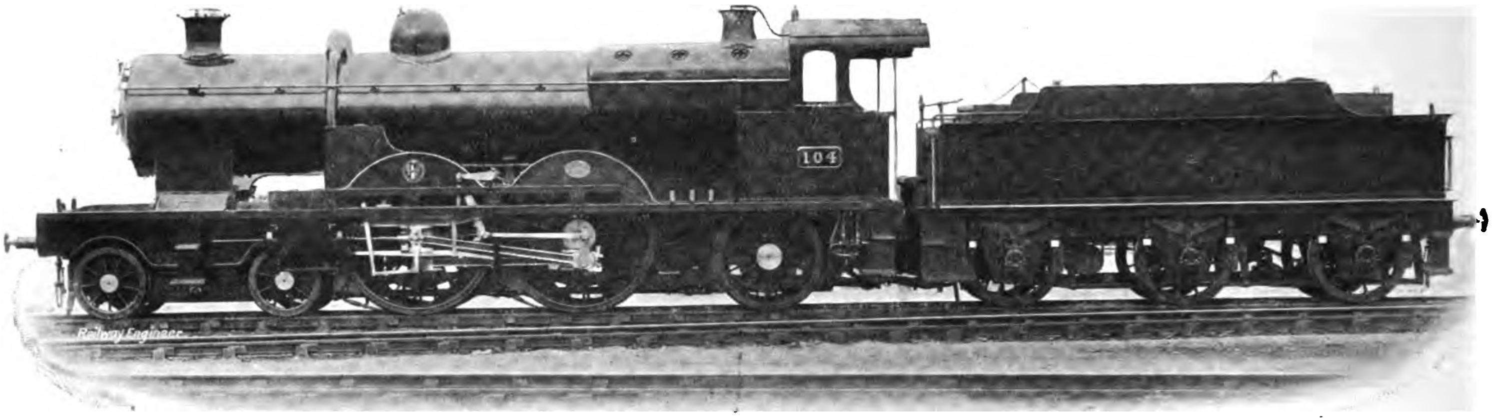


Fig. 2.

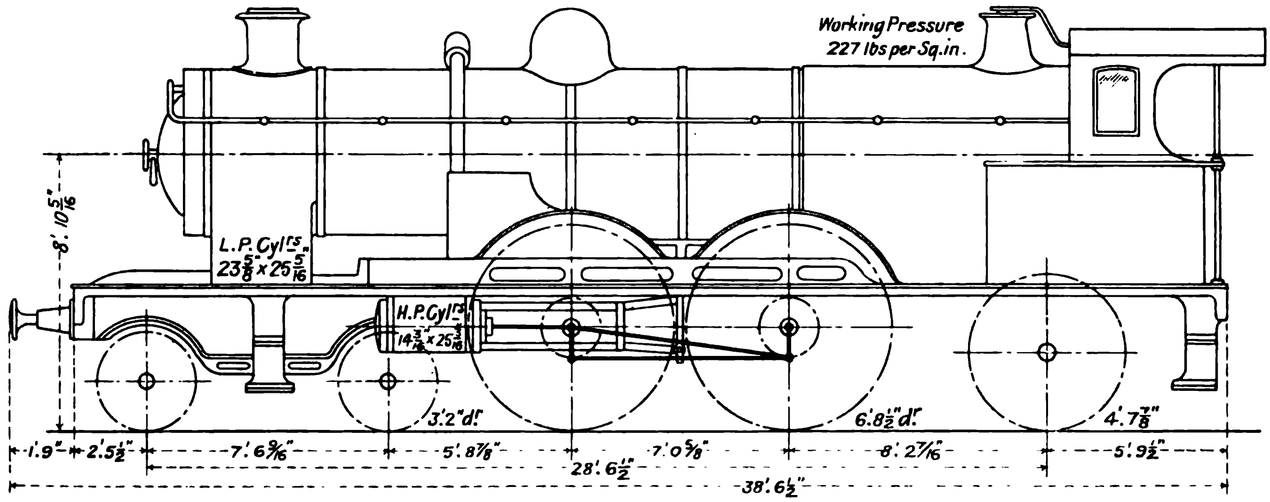


Fig. 3.—New de Glehn System Four-Cylinder Compound Engine; Great Western Railway.

J. Churchward, for working fast passenger trains on the G.W.R. main line within certain limitations of distance. Locomotives of this class are standard on the London, Tilbury and Southend R., where a fast and heavy passenger traffic is wholly worked by them. They are, however, quite new to the Great Western R.

The cylinders, wheels, and motion of these new tank engines are identical with those of the "County" class express locomotives on the same railway, but the boiler, although of the same type, having an extended coned ring between the first course and the firebox, is somewhat smaller, owing, no doubt, to the fact of the side tanks being present in this case. A distinctive feature of the design is the diameter of the coupled wheels, viz., 6ft. 8½ins. on tread, the largest in use on any railway in connection with tank locomotives.

Below are the leading particulars: — Cylinders, 18ins.

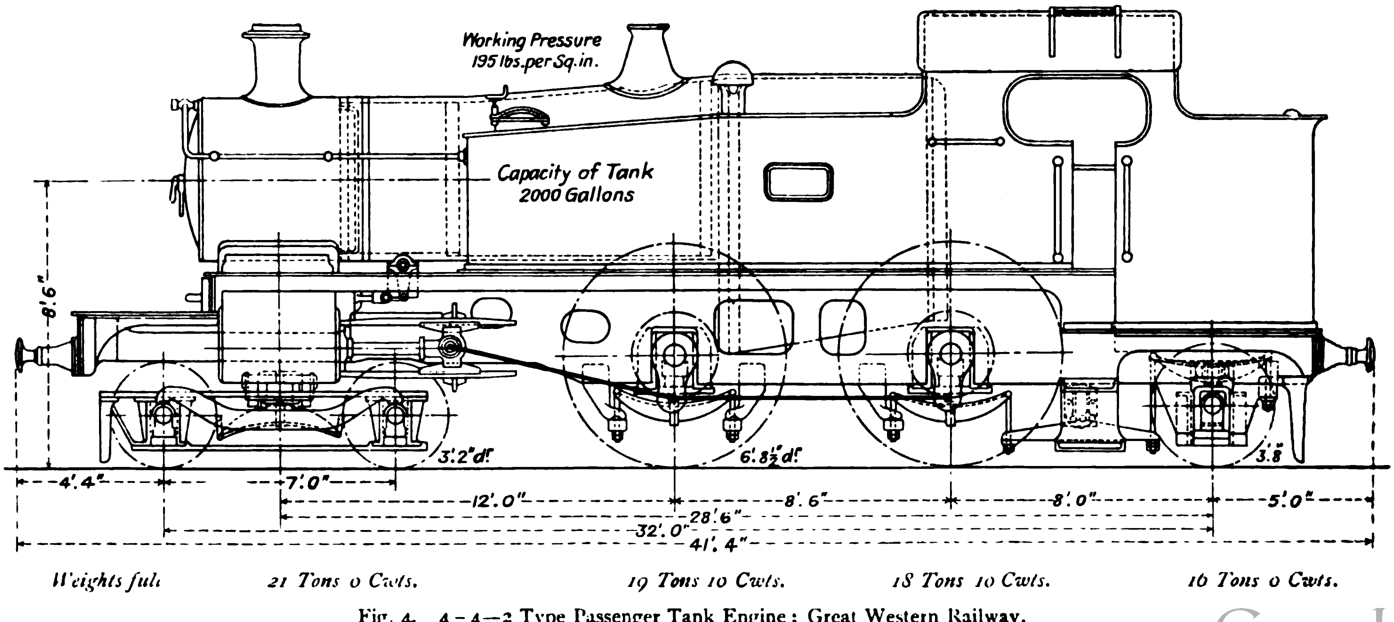


Fig. 4. 4-4-2 Type Passenger Tank Engine; Great Western Railway.

diam. by 30ins. stroke. Wheels, coupled, 6ft. 8½ins. diam.; bogie, 3ft. 2ins. diam.; radial truck, 3ft. 8ins. Boiler—diam. of barrel, 4ft. 5¼ins. and 5ft. 0½in.; length of barrel, 11ft.; number of tubes, 289; diam. of tubes, 1⅞ins.; length of tubes, 11ft. 4 3/16ins. Heating surface, tubes, 1,396·58 sq. ft.; firebox, 121·3 sq. ft.; total, 1,517·89 sq. ft. Grate area, 20·35 sq. ft. Working steam pressure, 195lbs. per sq. in. Water capacity of tanks, 2,000 gallons. Tractive force, 21·190lbs.

The engine is fitted with "both direction" water pick up apparatus, and the springs of the trailing coupled wheels are connected by equalising beams to those of the radial pair below the bunker.

On the Lancashire and Yorkshire R. Mr. George Hughes, chief mechanical engineer, has put into service a new series of 2-4-2 type radial side tank passenger locomotives (fig. 5). The new engines are similar in many respects to those designed for the same service by Mr. J. A. F. Aspinal, of which a large number are in use, but they have Belpaire boilers and extended smoke-boxes and Hoy's patent "pop" safety valves are mounted over the firebox.

The chief dimensions are:—Cylinders, 18ins. diam. by 26ins. Wheels, radial, diam., 3ft. 7⅜ins.; driving and trailing, 5ft. 8ins. Wheel base, 24ft. 4ins. Centre of front radial wheels to driving, 7ft. 10½ins. Driving to trailing, 8ft. 7ins. Trailing to hind radial, 7ft. 10½ins. Weight loaded:—Front radial wheels, 13 tons 16 cwts.; driving wheels, 17 tons 10 cwts.; trailing wheels, 15 tons 18 cwts.; hind radial, 13 tons 9 cwts.; total, 60 tons 13 cwts. Boiler — diam., 4ft. 5ins.; length between tube plates, 10ft. 9⅜ins. Firebox—length, 6ft. 4ins.; width, 4ft. 1in.; height (front), 5ft. 11⅞ins.; height (back), 4ft. 6⅜ins. Tubes—number, 220; outside diam., 1¾ins. Heating surface—tubes, 1,086 super. ft.; firebox, 107 super. ft.; fire grate, 18·75 super. ft. Tank—gallons, 1,540. Coal bunker, 3 tons 3 cwts.

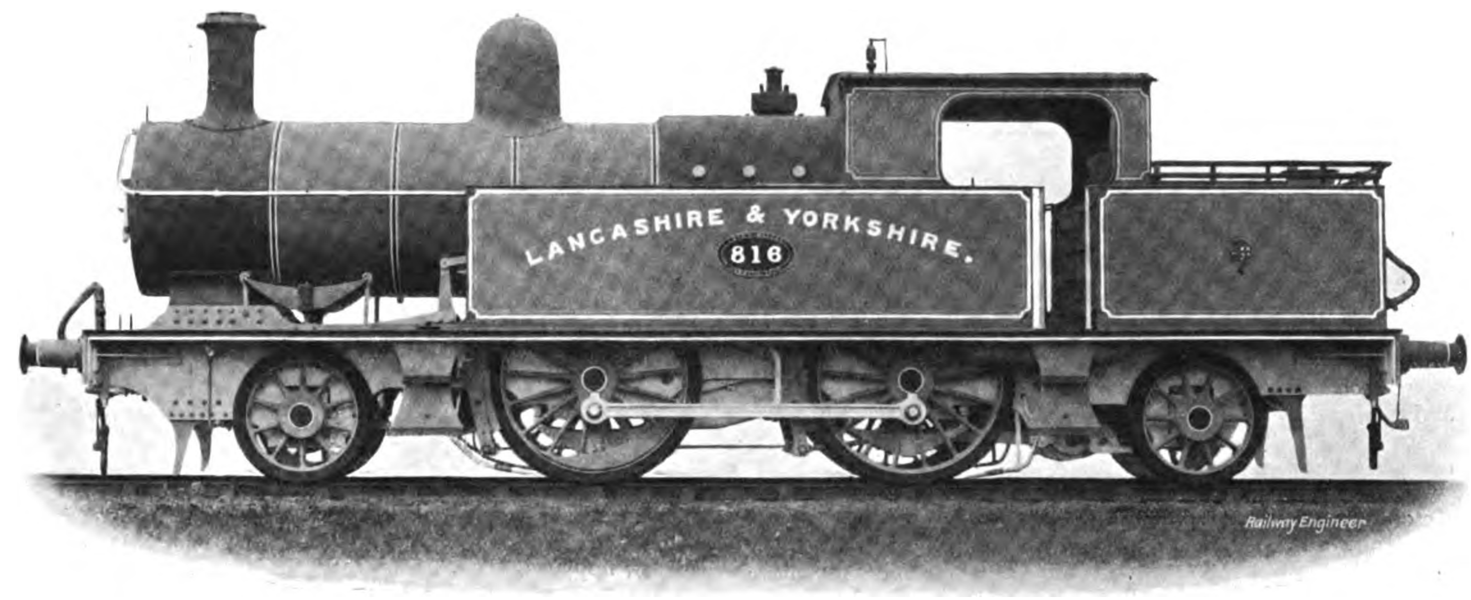


Fig. 5. 2—4—2 Type Radial Side Tank Passenger Engine; Lancashire and Yorkshire Railway.

Egyptian State Railways, 1904.*

The report of the Board of Administration, consisting of Messrs. J. H. L'E. Johnstone (chairman), J. Barvis and Scauder Fahmy, upon the working of the Egyptian State Railways, Telegraphs and the Port of Alexandria, states that:—

The railway earnings amounted to £E2,603,216 against £E2,320,535 in the previous year, and were divided as follows: —Coaching, £E1,188,385 (+£E192,504); goods, £E1,401,485 (+£E89,339); sundry, £E13,346 (+£E838). These figures represent a yield per kilometer (0·621 mile) of £E1,118, or about 12%.

The total number of passengers carried was 17,724,922, an increase of 19% over the previous year. Nearly 16 millions of the passengers were 3rd class. The total receipts were £E1,188,385, or an increase of 19%. There was an increase of from 10 to 30% in every class of coaching traffic, and it works out to 170 milliemes per coaching train kilom. as against 152 mill. in 1903.

The goods earnings were £E1,401,485, against £E1,312,146 in 1903, and represent 254 milliemes per goods train kilom. against 256 mill. The total agricultural tonnage was 1,382,503 (+164,244), and for other goods 2,147,056 (+317,650), or a total net increase of 469,698 tons.

The working expenses amounted to £E. 1,369,916, against £E. 1,256,743 as under:—

	Expenses. £.E.	Total Expenses. %	Gross Earnings. %
Way and works ...	361,031	26·36	13·87
Locomotives ...	468,292	34·19	17·99
Car and wagons ...	170,641	12·46	6·55
Traffic	226,567	16·54	8·70
General charges ...	100,390	7·32	3·86
Miscellaneous ...	42,995	3·13	1·65
Total ...	1,369,916	100·00	52·62

These expenses are equivalent to £E. 588 per open kilom. against £E. 539 in 1903 and to 109 mill. against 108 mill.

The total expenses for the Way and Works represent a cost per kilometre of track (including sidings) of £E. 109 against £E. 88 in 1903. They include £E. 133,893 for renewals, new works and big repairs.

The total working cost of the Loco. Department measured

*An abstract of the previous report appeared in *The Railway Engineer* for November, 1904, p. 363.

by the engine duty performed was 26 mill. per kilometre run against 31 mill. in 1903. These expenses include £E. 39,224 for new engines and new machinery. The average price of coal in 1904 was £1·021 per ton, against £1·095 in 1903, including freight, Custom dues, &c.

The Carriage and Wagon expenses represent a cost of 691 mill. per 1,000 vehicle kilom. in 1904 against 580 in 1903. This increase is explained by the fact that £E. 64.690 was spent in 1904 on new vehicles and new machinery against £E. 20,210 in the previous year.

The traffic expenses represent 18 mill. per train kilom. against 19 mill. in 1903.

The general expenses work out to £E. 43 per kilometre of line open to traffic in 1904 against £E. 42 in the previous year.

The miscellaneous expenses are equivalent to £E. 18 per kilom. open in 1904 against £E. 29 in 1903. The excess in 1903 is due to the fact that the compensation for injuries and damages on account of accidents practically represented the expenses of two years.

The total length of the lines without sidings was 2,701 kiloms. at the end of 1904, and the total length of sidings was 587 kiloms. The number of stations open to traffic was 269.

The total kilometrage run was 12,510,512 train kiloms. and 5,026,950 kiloms. for shunting and trial work. The locomotives consumed 174,298,800 kilogs. of coal.

The application of vacuum brakes to more than 40 trains has enabled the speed of the local and branch services to be increased, and while giving a better service to economise stock and engines.

On April 8th signal cabins were opened at Pont-Lemoun and Demerdache stations with points and signals properly interlocked, on the Saxby and Farmers' system. Tyers' single wire block instruments are used in these cabins, the first of the kind installed in Egypt.

Gas fitted coaches are now being run in almost all main line trains, and Stone's system of electric lighting is in use in the principal expresses.

107 coaches were fitted with gas lighting apparatus in 1904, and there are 27 sets in hand.

71 gas fitted coaches and 7 fitted with electric light are on order from Europe for delivery this year.

Experiments have been made to determine the most satisfactory type of lamp to adopt for large stations, yards and goods platforms, with the result that the "Lux" petroleum incandescent lamps have been found to give excellent results. 100 lamps have already been erected and another 150 are on order. Where the lighting of a small area only is required, such as offices, station waiting rooms, signal cabins, &c., a new type of incandescent lamp, the "Record," has been tried with satisfactory results. Though the majority of personal accidents are of minor importance, it is noted with regret that they are on the increase. The figures compare unfavourably with those of any European country, but this is mainly to be ascribed to the bad eye-sight of the native population and to their carelessness.

Ferro-Concrete, and some of its most Characteristic Applications in Belgium.*

By M. ED. NOAILLON, of Chênée, near Liége.

(*Concluded from page 340*).

One of the special features of the bridge is that it is built upon foundations constructed by a comparatively new process —the method of mechanical compression of the soil. The piers and abutments rest upon a group of concrete piles driven deeply into the bed of gravel, which is strongly compressed by the method adopted. The piles are re-inforced by vertical bars of steel which are continued into the piers and abutments, so that the whole is solidly bound together. The advantage of this method is to solidly root the bridge into the earth, so that it has a resistance amply sufficient in case of a floating accumulation of ice occurring which temporarily transforms the bridge into a dam.

From the point of view of its construction the bridge is considered as a cantilever with unequal arms, the shorter arm balancing the longer by the weight of the abutment.

The roadway is a platform 7·9ins. thick, and forms a tension member by means of its re-inforcement, and it is supported by the arches which form the struts. In the neighbourhood of the keystone, and for about 82ft. in length, the roadway is solid with the vault of the principal span. This vault is 2·46ft. thick at the haunches, and 1·97ft. thick where it dies into the roadway; it diminishes further until at the crown the roadway and arch together are only 1·15ft. thick. In the parts adjoining the pier, where the vault is clearly separated from the roadway, the latter is supported by three vertical struts 7·85ins. thick; one is the axis of the bridge, and the other two forming solid spandrils. The width of the arch being only 18ft. the sidewalks are carried upon brackets 7·4ft. long. The roadway is covered with asphalt, and the sidewalks are paved with artificial stone.

The same firm built, also upon the Hennebique system, a bridge above the high road and the railway at Val Benoit.

This is a skew bridge at an angle of 80°, and is 39·5ft. wide. It has three spans, of which the two principal ones are 39·4ft. and 59ft. in length normally to the axis. The roadway consists of a platform 4·7ins. thick, supported by four lines of straight girders connected together by transverse joints extended outwards by brackets, which serve to support the overhung sidewalks.

These girders rest upon two piers, each of four columns, and also upon abutments at the ends. The foundations are formed by masonry wells carried down to a solid bearing 13·52ft. deep, except for the abutment adjoining the railway which is on the slope of a hill. At this point a solid wallwork 8·2ft. thick has been built, anchored about 32·8ft. deep into the soil, so as to hold back the masses of clay which are above and prevent a landslip.

Framework for Lead Chambers at the Chemical Works of the Engis Company, Limited.

This company, under the advice of its managing director, M. L. G. Fromont, who is an engineer, has adopted the system of re-inforced concrete for the construction of various foundations and for the construction of tunnels, cellars, platforms, hoppers, silos, frameworks for lead chambers, and for various towers, such as are required in the Glover and Gay Lussac processes.

Among the interesting applications should be specially mentioned the framework for lead chambers, which constitutes one of the boldest innovations not only in the method of construction itself but also in the special apparatus which are enclosed.

It is known that the most modern constructions designed to shelter and support the lead chambers are essentially composite structures, generally made of brick in the lower portion and in iron and wood for the upper portion.

The combination and connection of the various heterogeneous parts presents many weak points at the lines of meeting; joints and connections for all these junctions represent so many points for attack either by the sulphur gas, or by sulphuric acid, when an accident has happened.

Besides this, the enormous quantity of wood used for this kind of structure makes them highly combustible, and exposes the manufacturer to serious risks.

These disadvantages alone suffice to justify the use of ferro-concrete, and the structure built at Engis, from designs prepared by M. Faure under the guidance of Professor Henri Deschamps, constitutes really a monolith from the foundations to the summit without joints or discontinuity.

From the point of view of resistance to gas and acid liquids the composition and treatment of the concrete has been the subject of special study, and the mixtures employed have given perfect satisfaction.

It is impossible for the author to give either a plan or photographic views of the interior of these chambers, for their

* Read before the Institution of Mechanical Engineers at Liége, June, 1905.

special arrangements, which are due to the investigations of M. Fromont, are technical secrets which cannot be divulged.

The structure occupies in plan an area 230ft. long by 92ft. wide; it has a total height of 82ft., of which 23ft. is for the lower portion and 59ft. for the upper part.

The lower portion is formed of piers placed 16·4ft. apart, each consisting of four columns connected at their upper ends by a horizontal girder 92ft. long aided at various points by struts fixed to the base of the columns. The total load carried by the lower structure is about 3,700 tons. At certain points the girders are connected together by joints, and there is a flooring of ferro-concrete which serves as a footway all round.

The superstructure consists of vertical columns 59ft. high, which rise from the ends of each horizontal girder, and besides these there are also columns in the centre of the building. At the upper part all the columns are connected together by horizontal girders with a span of 44·5ft., and each of these bears a distributed load of 45 tons. The horizontal connections of these girders form the roof terrace.

The columns are solidly connected together by vertical partitions of ferro-concrete, which, in conjunction with various well-designed struts, give the desired rigidity to the entire structure. The building was erected in 1900, and since that date has been in constant use and has given no trouble whatever.

Another marked advantage possessed by this building is that, owing to the careful distribution of the materials, which are calculated with ample factors of safety, as was proved by rigorous tests, it has not been more expensive to construct than the old unsatisfactory composite buildings already described.

8, 10 and 12-Ton Private Owners' Wagons.

We have abstained from publishing this important Specification, which was issued early in the year, until the drawings were also available. These have now been issued, and by the courtesy of Mr. James Holden, M.Inst. C.E., locomotive, carriage and wagon superintendent of the Great Eastern R. and chairman of the Clearing House Wagon Committee, we are able to publish the new Specification and the revised drawings. It must be understood that this specification (dated December, 1904) entirely supersedes that dated April, 1903, and which we published in our issue for January, 1904.

Standard Specification for the Construction of Private Owners' 8, 10, and 12-ton Wagons (and for the re-construction of 8 and 10-ton Wagons); also for the conversion of 8 and 10-ton Dead-buffered Wagons to work upon the lines of the Railway Companies.

December, 1904.

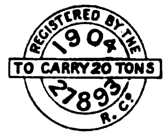
By the word "Owner" is meant the party for whose purpose the Wagons are used upon the Railway.

Private owners may build the body of the wagon so as to suit best their own requirements, provided they comply strictly with all the provisions and requirements set forth in the specification. A working, drawing or tracing, which will be retained for future reference by the railway company registering the wagon, together with a description of the wagon proposed to be built, must first be submitted for approval to the wagon superintendent of the company upon whose line the wagon is to be "at home," and, if they be found to conform in all particulars with this specification, and to the standard drawings annexed, sanction will be given for the construction of the wagon; but before any such wagon is allowed to run on the company's railway, the railway company's wagon superintendent, or his inspector, will examine it, and, if he be satisfied that the specification has been fully carried into effect, will fix a register plate to each side of the wagon, which plate will bear the name of the railway company registering it, the registered number, and the maximum load to be carried; and the plate so affixed will pass the wagon to work over the company's or any other line of railway, except as shown in clause 2 hereof, without further registration. This registration will not affect the right of any railway company to inspect any registered wagon, and if found in any respect defective to stop or refuse it.

All new and re-constructed wagons and dead-buffered wagons converted to spring buffers will be registered by the company owning the line where the wagons are at home or where the owner's place of business is situated, although the wagons may have been built or converted at works on another company's line. If the owner's place of business, either works or office, be accessible to, or by, two or more railway companies, it shall me permissible for either of the companies to register the wagons.

The word "approved," where it occurs in this specification, means approved in writing by the railway company which registers the wagon.

Two register plates are to be secured to the solebars of the wagons, one at each left-hand corner, and as nearly as possible 2ft. from the outside of the headstocks, and will, for new wagons, be of the following design :—



For designs of register plates for re-construction and converted wagons, see pp. 10 and 11 hereof.

Dimensions.

1. No wagon to exceed 8ft. 6ins. wide over all nor to exceed in height 10ft. at the sides and 11ft. 6ins. in the middle above the top of the rails.—(No wagon for tipping coal in the Bristol Channel ports must be of a greater width than 8ft. 3ins.)

The length of coal wagons not to exceed 16ft. 6ins. over headstocks. Coke wagons may be made 17ft. 6ins. over headstocks.

The wheel base not to be less than 8ft. nor to exceed 9ft.

The load not to exceed 8, 10, or 12 tons respectively, and the building of 8-ton wagons to be limited as much as possible.

Tare.

2. Maximum tares :—

Doors.	Single-spoke wheels with wrought iron centres. 2½ inch sheeting. 10 tons. T. cwts.	12 tons. T. cwts.	Double-spoke wheels with cast iron centres. 2½ inch sheeting. 10 tons. T. cwts.
Side only	5 18	6 6	6 1
Side and bottom ...	6 0	6 8	6 3
Side and end ...	6 1	6 9	6 4
Side, end, and bottom	6 3	6 11	6 6

Extra to the above the tares may be increased :—

*For 3in. sheeting, 3 cwts.
For coke rails, 4½ cwts.
*For 2¼in. tyres, 3½ cwts.
For English oak frames, 2 cwts.
*For pitch pine sheeting, 2 cwts.
For commode rod and steps, ½ cwt.

*For hinged top planks, 1 cwt.

For coke wagons of full length, 2 cwts.

* Wagons fitted with any of the following, viz.: 3in. sheeting, 2½ins. tyres, pitch pine sheeting, hinged top planks, will not be accepted on the Barry R., the Port Talbot Railway and Docks, the Rhondda and Swansea Bay R., the Rhymney R., and the Taff Vale R. Companies' lines.

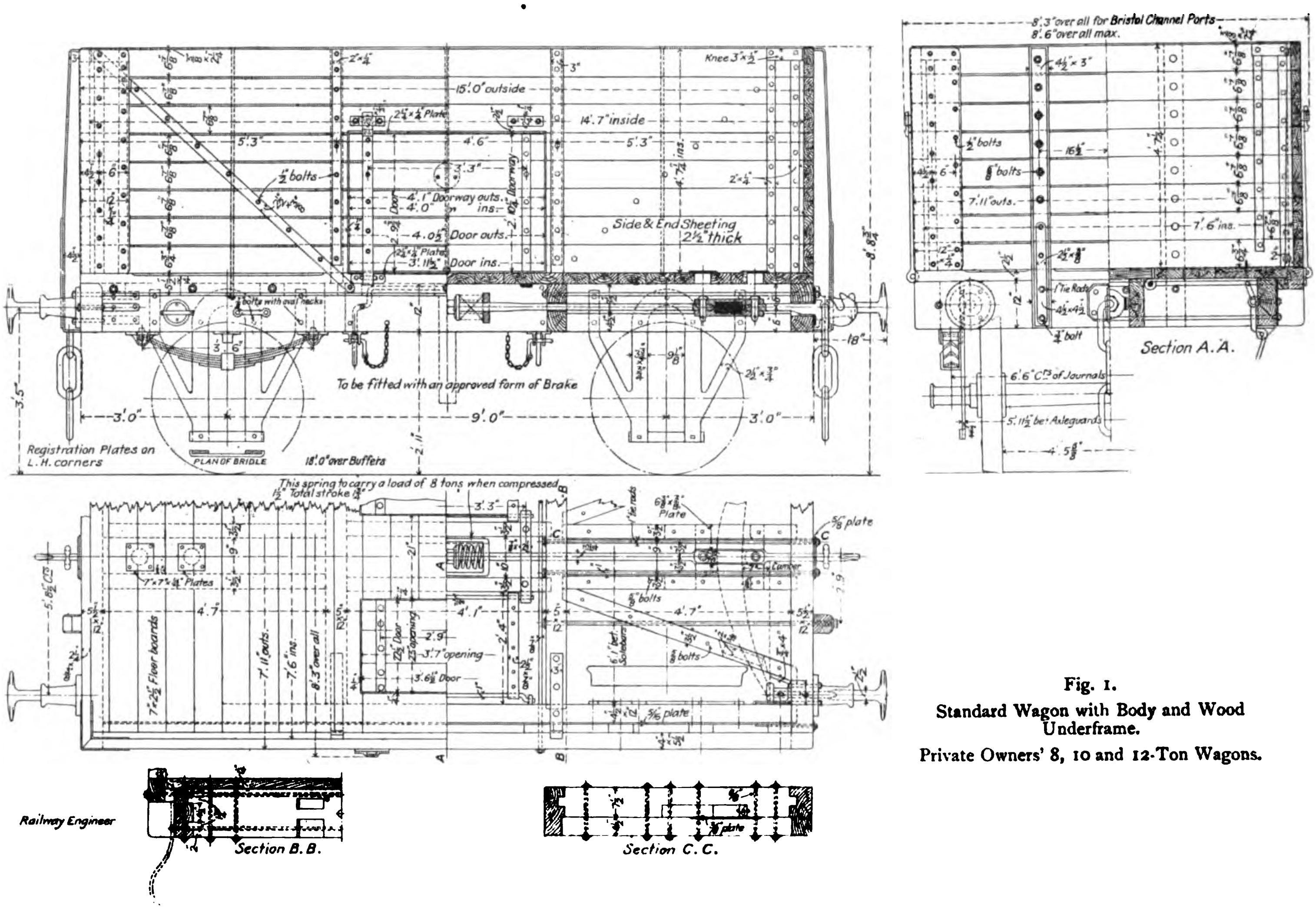
The above-named tares are for wagons of the maximum dimensions given in the specification, and smaller wagons must be correspondingly reduced in tare.

cross-bearers to be 12ins. by 5ins., and the longitudinals and diagonals to be not less than 12ins. by 3½ins. The whole to be of approved form and dimensions.

Doors.

6. Horizontally hung side doors when down must clear rail level by 8½ins. with the wagon unloaded, and vertically hung doors when open must not extend beyond 6ft. 6ins. from the centre of the wagon.

The bottom doors of hopper wagons must, when down, and the wagon unloaded, clear the rail level by 7ins.



Railway Engineer

Fig. 1.
Standard Wagon with Body and Wood Underframe.
Private Owners' 8, 10 and 12-Ton Wagons.

Tank Wagons.

3. Construction of tank wagons to be in accordance with specification and drawings specially provided applicable thereto.

Body.

4. The bodies of the wagons may be made of wood, iron or steel of approved quality, strength, form and dimensions. For wood bodies 2½in. or 3in. sheeting may be used.

The side, end, and floor plates of iron or steel bodies to be of approved thickness and firmly secured with rivets.

Commode rode and steps to be fixed when required.

Underframe.

5. The underframe to be made of good sound white oak, or other timber not less in strength and quality than white oak (except when preferred to be made of iron or steel—see clause 22). The solebars to be 12ins. by 5ins. except where they are plated, in which case they may be 12ins. by 4½ins.; the plate to be of steel or iron $\frac{6}{16}$ in. thick the full depth and length of solebar. The headstocks to be 12ins. by 5½ins., the

Quality of Wrought Iron or Steel.

7. All mild steel or wrought ironwork in the body, and underframe, and all pertaining or attached thereto to be made to the specification attached.

Draw-Gear.

8. The draw-gear throughout to be made of the best cable iron, or mild weldable steel, of Government chain proof quality, and to be continuous and elastic, and of the dimensions shown on the standard drawings. The drawbar pins to be of steel of the same quality as the axles. The chains to be of 1½in. diam., and to hang loosely in the drawbar; all links to be welded at the side; 2 per cent. of the chains to be tested, if required, and to withstand a breaking strain of 50 tons. Pins and shackles not to be used.

When couplings are worn below 1⅛in. in thickness at the end they must be removed.

Axle-guards.

9. The axle-guards to be made of 3¾ins. by ¾in. iron, and the wings to be 2½ins. by ¾in.; the bottom stay or bridle to

be 2ins. by ⅝in., or other approved design. The bolt holes to be oval, as shown on the drawing for wood underframes, and the bolts to have oval necks to suit them. The axle-guards to be fastened to the wood underframe with ⅞in. bolts and to iron or steel underframes with ⅞in. rivets or bolts.

Bolts and Nuts.

10. All bolts and nuts to be screwed to Whitworth standard thread, and, wherever possible, all nuts and cotters must be placed outside, so as to be easily seen if working off.

Break.

11. Each wagon to be fitted with a double block break, having a cast iron block applied to one wheel of each pair, and a lever guard with a pin and chain (which in its lowest position shall not hang lower than 6ins. above the running rail) or rack, for holding the lever down; also safety loops for preventing the break-work from falling.

Buffers.

12. Laminated buffing springs are to be used; the buffers to be 18ins. in length from headstock to face, which is to be 12ins. diameter; the centres to be 5ft. 8½ins. apart and 3ft. 5ins. high from top of rails with the wagon unloaded; the buffer guides to be not less than 10ins. in length.

Buffing Springs.

13. The buffing springs to be made of 12 plates of 3ins. by ½in. steel, and to be tested at the maker's works by an inspector, strictly in accordance with the specification in clause 27 (*vide* appendix to this specification). The spring buckle must be made of forged iron or steel, or in accordance with the method shown in the accompanying drawing (10).

Bearing Springs.

14. For 8 and 10-ton wagons the bearing springs to be made of either 5 plates 4ins. by ⅜in. steel, or 9 plates 4ins. by ½in. steel; and for 12-ton wagons either 5 plates 4ins. by ⅜in. steel or 10 plates 4ins. by ½in. steel; and they must have a wrought iron hoop 3ins. by ½in. with ½in. rivet in middle, or a flat rivet of equal strength may be used if preferred. They must be made of approved material to the standard drawings and be tested at the maker's works by an inspector, strictly in accordance with the specification in clause 27 (*vide* appendix to this specification).

The bearing springs to be secured in position by bolts and nuts, as shown in the standard drawings.

Axle Boxes.

15. The axle-boxes to be of good strong iron or steel (cast or pressed), and to have bronze or gun metal bearings well fitted in. The grease chamber to have a capacity of about 100 cubic inches, and the lid to be made of wrought or malleable cast iron well fitted, and with a spring upon it; a ⅞in. bolt to go through the axle-box underneath the centre of the journal. The top of the axle-box to be so formed that the bearing spring will "bed" into it 2ins.

An efficient shield to be put in the back of the box to keep out dust.

Each axle-box must have cast or stamped upon the front the size of the journal for which it is constructed.

Other approved axle-boxes may be used for either grease or oil.

12-ton wagons to be fitted with oil axle-boxes of approved pattern, but, if desired, 12-ton wagons used for tipping coal, etc., may have grease axle-boxes.

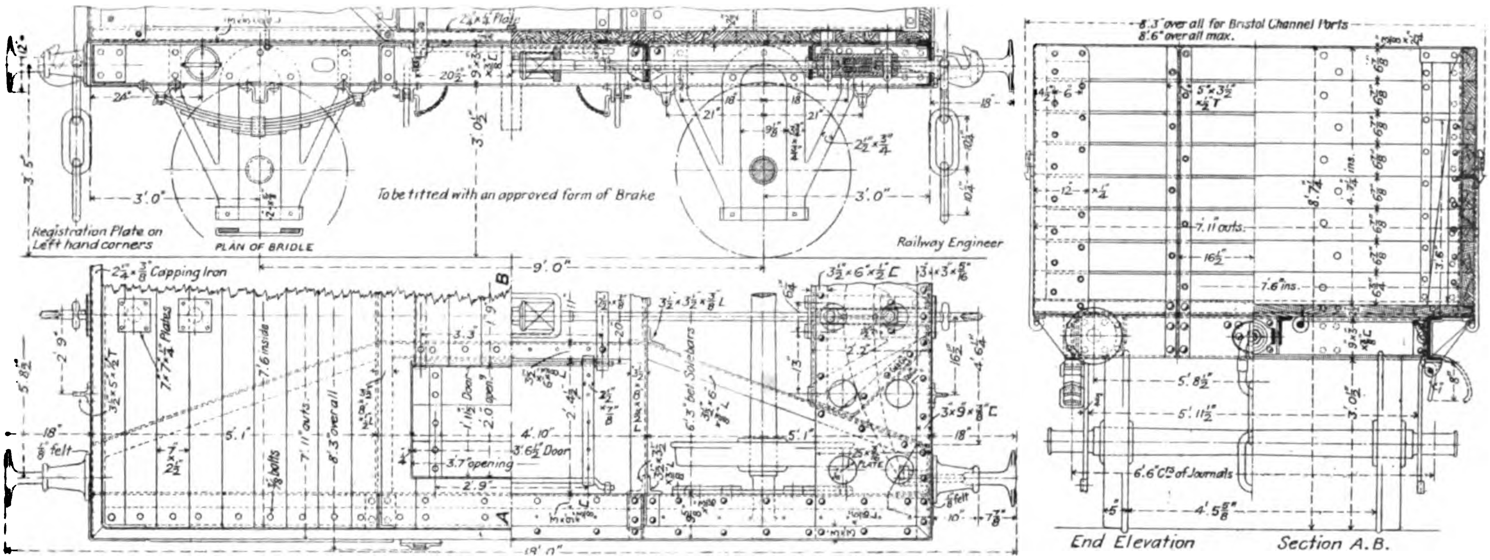


Fig. 2.—Standard Wagon with Steel Underframe and Wood Body; Private Owners' 8, 10, and 12-Ton Wagons.

Tyres.

16. The tyres to be of acid steel, either Open Hearth or Bessemer, and to be subjected to the tests set forth in the appendix to this specification.

The tyres to be 5ins. wide and not less than 2ins. nor more than 2½ins. thick on tread when finished, truly bored out, with not more than $\frac{1}{16}$in. allowance for contraction, and secured to the wheels by one of the approved modes of fastening shown on the standard drawings. Neither rivets nor bolts to be passed through or into the tyre.

Axles.

17. The axles to be made of acid steel, either Open Hearth or Bessemer, or, if preferred, of wrought iron, and to be subjected to the tests set forth in the appendix to this specification.

Axles, 8 and 10-ton Wagons.

18. For 8 and 10-ton wagons the axles to be 6ft. 6ins. in length from centre to centre of journals, 5¼ins. diam. through the boss of the wheel, and gradually tapered to 4½ins. in the middle. There must be no shoulder on the axle behind the boss. The journals to be 8ins. long by 3¾ins. diam., and the whole strictly in accordance with the standard drawing.

Axles are to be discarded when the journals are, in t

case of 8-ton wagons, worn down to $3\frac{3}{8}$ins., and in the case of 10-ton wagons to $3\frac{1}{2}$ins. diam.

Axles, 12-ton Wagons.

19. For 12-ton wagons the axles to be 6ft. 6ins. in length from centre to centre of journals, $5\frac{1}{2}$ins. diam. through the boss of the wheel, and gradually tapered to $4\frac{7}{8}$ins. in the middle. There must be no shoulder on the axle behind the boss. The journals to be 9ins. long by $4\frac{1}{4}$ins. diam., and the whole strictly in accordance with the standard drawing.

Axles under 12-ton wagons must be discarded when the journals are reduced below $3\frac{7}{8}$ins. diam.

Wheels.

20. For 8 and 10-ton wagons the body of the wheel to be made of wrought iron of good marked bar quality or of mild steel, with eight spokes, which may be either solid or open. The bosses to be 7ins. through and $9\frac{1}{2}$ins. diam. for solid spokes, and 7ins. through and $10\frac{1}{2}$ins. diam. for open spokes. The rim or periphery to be not less than $1\frac{1}{4}$ins. thick, soundly welded throughout, and turned exactly to 2ft. 9ins. diam., and in section equal in strength to the form shown on the standard drawings. The boss to be bored out, and the wheel forced on to the axle by hydraulic pressure of not less than 50 tons; no keys are to be used.

Cast iron boss wheels having bosses 13ins. diam. will be accepted until 31st December, 1905; after that date no new wheels with cast iron bosses will be accepted.

Cast iron bosses must not be used on wagons of over 10 tons capacity.

If preferred the body of the wheel may be of cast or pressed steel to the design and dimensions on drawing No. 6.

For 12-ton wagons the body of the wheel to be made of wrought iron of good marked bar quality, or of mild steel with solid or open spokes and wrought iron boss. The bosses to be 7ins. through and 10ins. diam. for solid spokes, and 7ins. through and 11ins. diam. for open spokes. The rim to be not less than $1\frac{1}{4}$ins. thick, soundly welded throughout and turned to 2ft. 9ins. diam., and in section equal in strength to the form shown on the standard drawings. The boss to be bored out and the wheel forced on to the axle by hydaulic pressure of not less than 60 tons; no keys are to be used. If preferred the body of the wheel may be of cast or pressed steel to the design and dimensions on drawing No. 153.

Stamping of Ironwork and Steelwork.

21. All ironwork and steelwork as far as practicable to be stamped distinctly with the name or initials of the builder or owner.

Iron or Steel Underframes.

22. The underframe, if preferred, may be made of steel or iron of approved quality.

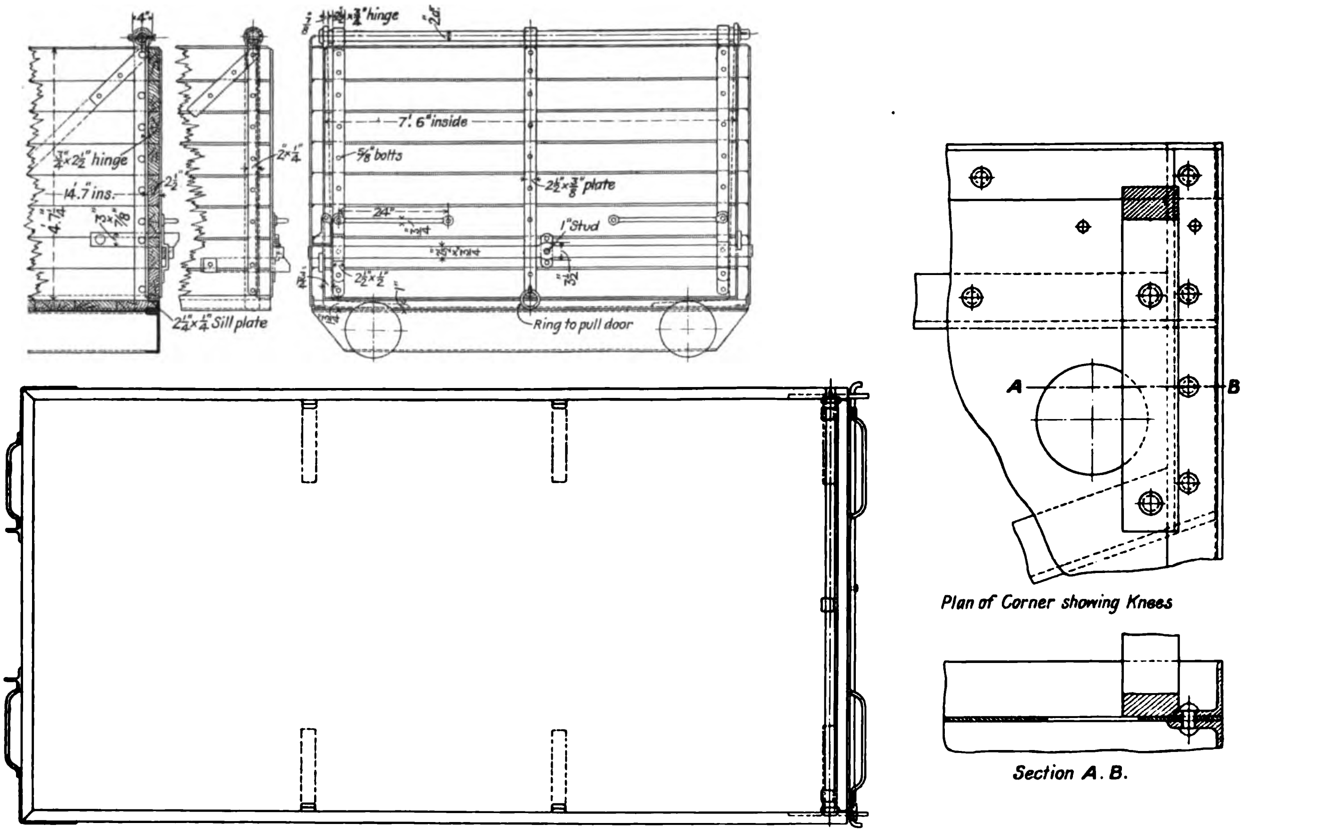


Fig. 3.—Standard Wagon with End Door, Wood Body and Steel Underframe ; Private Owners' 8, 10, and 12-Ton Wagons.

The approved general design is shown on drawings dated December, 1904, and the details, where such are not common to both forms of underframe, fully illustrated in drawings numbered 2, 3, 4, 5, 13, and 15 respectively

The dimensions of the principal members are as follows :—

Headstocks and solebars	...9in.	by	3in.	by	$\frac{3}{8}$in.	channel
Trimmers	...6	,,	$3\frac{1}{2}$	,,	$\frac{1}{2}$,,	,,
Middlebearers ...	...8	,,	$3\frac{1}{2}$	,,	$\frac{1}{2}$,,	angle
,, ...	...9	,,	3	,,	$\frac{3}{8}$,,	channel
Diagonals and longitudinals	...6	,,	$3\frac{1}{2}$	,,	$\frac{3}{8}$,,	angle
End stanchions ...	...5	,,	$3\frac{1}{2}$	,,	$\frac{1}{2}$,,	tee
Curb rails	...7	,,	3	,,	$\frac{5}{16}$,,	special angle, or
,, ...	...$9\frac{1}{2}$	,,	3	,,	$\frac{5}{16}$,,	,, ,, , or
,, ...	...3	,,	3	,,	$\frac{5}{16}$,,	special angle riveted to $\frac{3}{16}$in. plate
End rails	...3	,,	3	,,	$\frac{5}{16}$,,	special angle bars.

The whole to be so prepared that the ends have a good bearing upon the adjacent parts.

Stocks of Materials.

23. The stocks of materials for use under the specification of September, 1889, for 8 and 10-ton wagons, now held by wagon builders and repairers, are allowed to be used up; but no material that does not accord with this specification may be used after 31st December, 1904.

Repairs and Re-construction.

24. When any private owner's 8 or 10-ton wagon is repaired, such repairs must as far as possible be carried out in conformity with the standard specification under which they were built and to the satisfaction of the company's wagon superintendent; wagons built prior to 1887 are to be repaired under the 1887 specification, but when a dead-buffered wagon is so far worn as to require the following new members, viz.,

2 new solebars, or 1 new solebar and 3 cross members,

the wagon must be reconstructed, the limit of time between the replacement of solebars or main members being one year.

The wheels and ironwork may be used again provided they comply with the following conditions :—

Axles.—For wagons to carry a load of 8 tons to be not less than 5ins. diam. through the boss of wheel, 4ins. in the middle, and the journals not less than 7ins. long by $3\frac{7}{16}$ ins. diam.

For 10-ton wagons to be not less than 5¼ins. diam. through the boss of wheel, 4¼ins. diam. in the middle, and journals not less than 8ins. long by $3\frac{9}{16}$ ins. diam.

When an axle is in any part less in diam. than specified above it must be replaced by a new axle of the standard diameters for new wagons, but the length of the journals and the distance between centres of journals may be made to suit the width of the wagon to be reconstructed, provided that for a wagon to carry 8 tons the journals shall not be less than 7ins. long by 3¼ins. diam., and for a 10-ton wagon not less than 8ins. long by 3¾ins. diam.

Wheels.—For 8-ton wagons, wheel spokes to be not less than $2\frac{15}{16}$ ins. wide by $\frac{11}{16}$ in. thick; rims not less than 2⅞ins. wide by ⅝in. thick.

For 10-ton wagons, wheel spokes must not be less than $3\frac{7}{16}$ ins. wide by $\frac{11}{16}$ in. thick; rims not less than 3¼ins. wide by ⅝in. thick.

Tyres.—The tyres to be not less than 5ins. wide, and when turned up to be not less than 1¼in. thick.

Tyres fastened on to the wheels with rivets or bolts to be allowed to run until the wheels require re-tyring, when they must be re-tyred in one of the ways shown on the drawings of the standard specification.

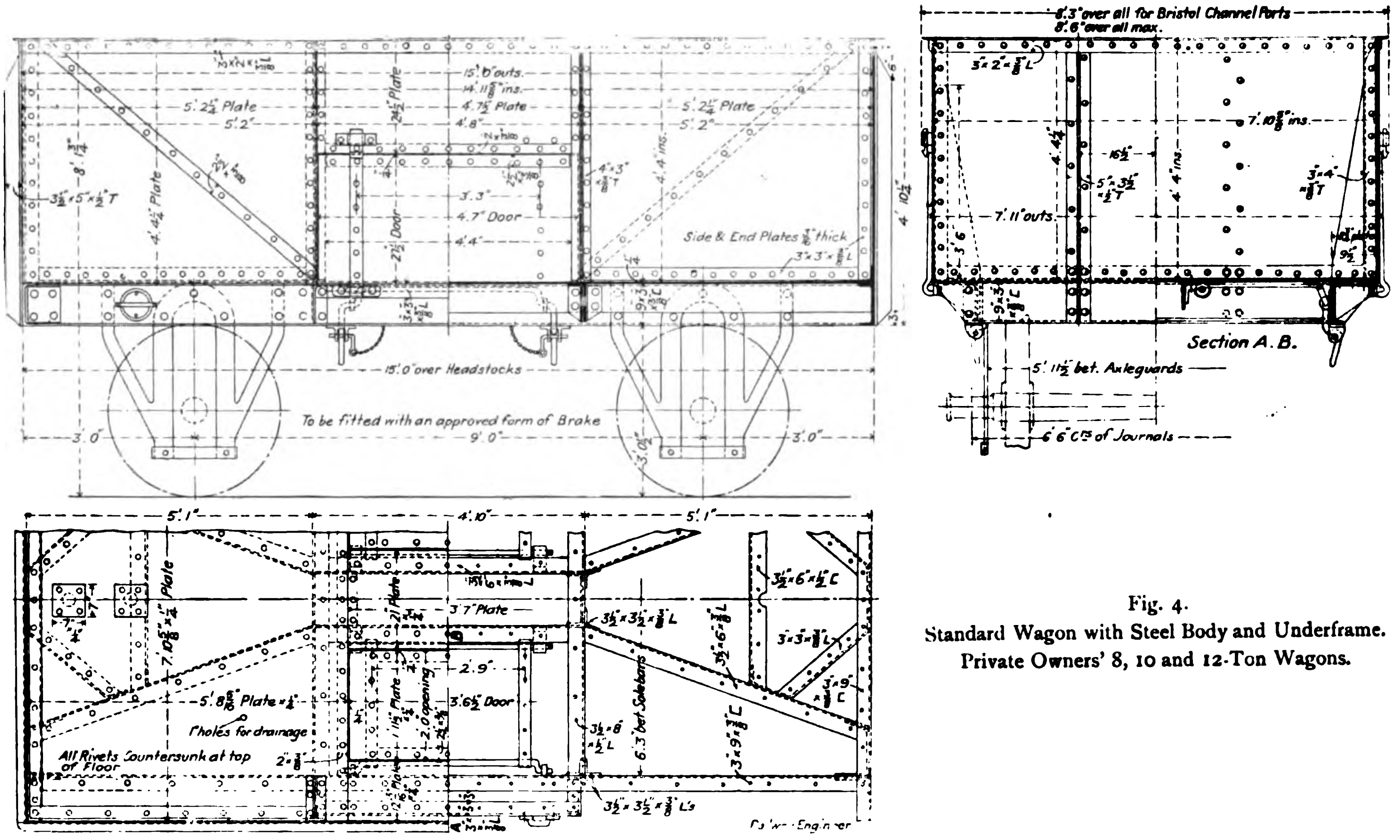


Fig. 4.
Standard Wagon with Steel Body and Underframe.
Private Owners' 8, 10 and 12-Ton Wagons.

Axleguards.—Crown to be not less than $3\frac{7}{16}$ ins. wide and $\frac{11}{16}$ in. thick, wings $2\frac{7}{16}$ ins. wide and $\frac{11}{16}$ in. thick, and to be fastened on to the wood solebar with ⅞in. bolts with oval necks.

Axle Boxes.—When the measurement from the inner shoulder of the journal to the outer face of the wheel boss is not less than 1¾ins. axle boxes must be fitted with dust shields, and the top of any new axle box must be so formed that the bearing spring will "bed" into it 2ins.

Axle boxes may be made with open bottoms provided that they be furnished with well-fitted keeps or under caps, and with the safety bolts shown on the standard drawing.

Bearing Springs.— All bearing springs to have the second plate from the top turned down 1in. at the ends. Either 3in., 3½in., or 4in. springs may be used again if in good condition and of full strength for the load to be carried. The four springs under each wagon to be uniform in all respects. The spring shoes to be fitted with safety bolts.

Buffing and Draw-gear.—The standard specification buffing and draw-gear to be adopted for all re-constructed wagons. When the solebars of a wagon are less than 6ft. 1ir

apart the corner knees may be let into the solebars, and such other modifications as are necessary may be made, particularly in the case of hopper or other specially-constructed wagons.

Break Gear.—The wagon must be fitted with a double block break with cast iron blocks. The old break gear may be used again if it is generally of good construction and in good condition. Safety loops shall be provided as shown on drawing (1) of the standard specification.

Wheel Base.—The wheel base of re-constructed wagons to be not less than 7ft. 6ins.

Inspection.—Every re-constructed wagon to be inspected

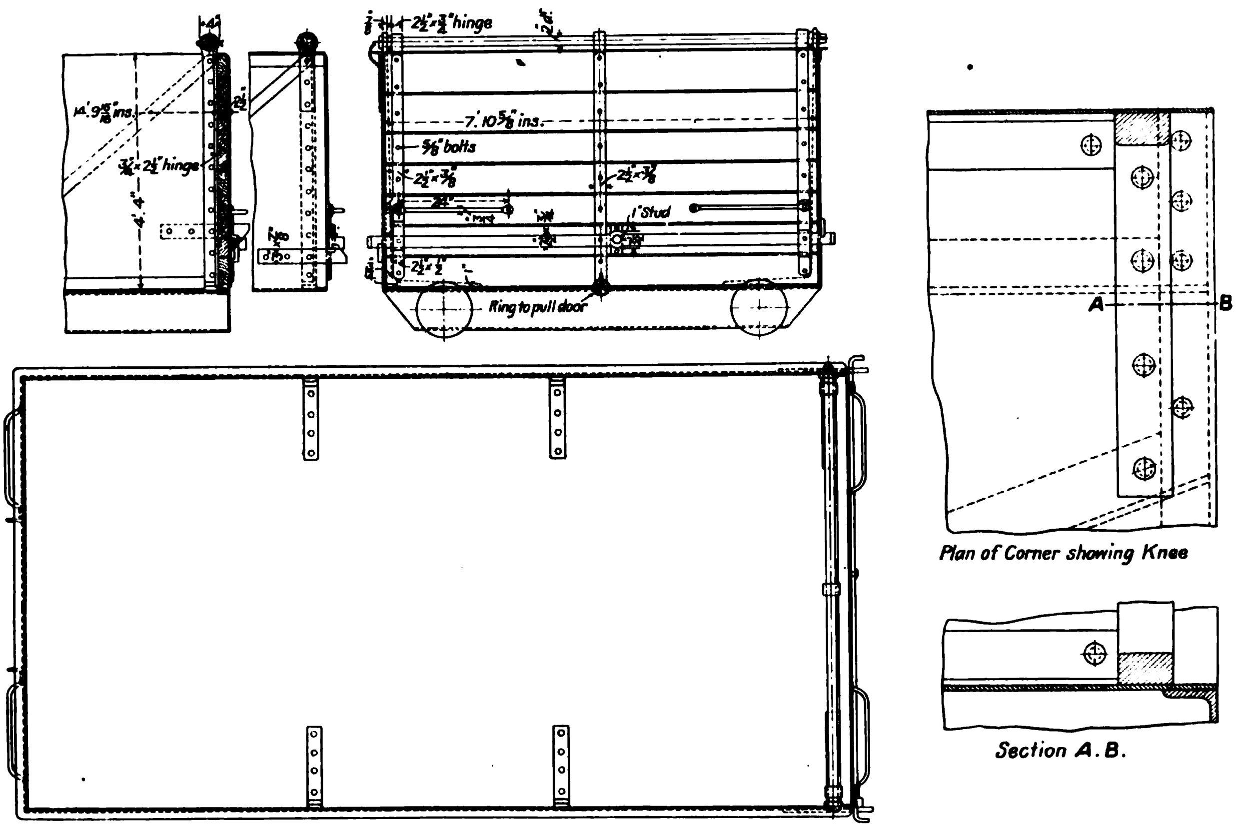
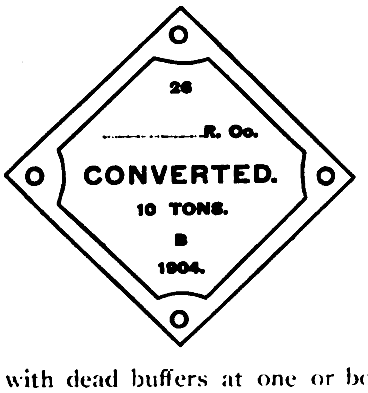


Fig. 5.—Standard Wagon with End Door, Steel Body and Underframe ; Private Owners' 8, 10 and 12-Ton Wagons.

and passed before being allowed to go into traffic, and a register plate of the following design to be affixed to each side thereof :—

The plate so affixed will pass the wagon to work over the company's or any other line of railway, except as shown in clause 2 hereof, without further registration.



New Tyres for Old Wheels.

25. In all cases where new tyres are required for old wheels the tyres must be fastened in accordance with the method set out in clause 16.

Dead-buffered Wagons.

26. "Dead - buffered wagons" means wagons with dead buffers at one or both ends.

On and after the 1st day of January, 1914, no wagons will be allowed upon the railways in Great Britain which are not fitted with spring buffers of approved type. Self-contained spring buffers of one of the patterns shown on drawing No. 161, or of any other pattern approved by the railway companies, may be put on dead-buffered wagons of a carrying capacity of not less than 8 tons, provided that such wagons have, or be at the same time fitted with, a continuous draw-bar, with a cradle equal in strength to that specified for in the drawings accompanying the standard specification for new wagons, the drawbars to be not less than 1⅜in. diam. at any point. The wheel base of converted wagons must be not less than 7ft. 6ins., and no more main members of the under-frame must be renewed than are permitted by the regulation for the re-construction of private owners' wagons. New headstocks are not to be counted in such renewals if the wagon is fitted with all of the following :—

Double cast-iron break blocks.

5¼in. wheel seats for 10-ton wagons and 5in. wheel seats for 8-ton wagons.

1½in. three-link welded couplings.

Springs up to standard specification.

Bolts through spring shoes.

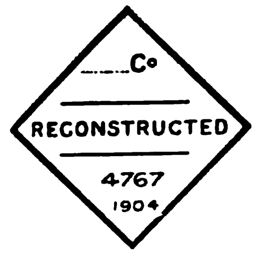
Cast or wrought iron or steel buffer cases.

When a wagon is sent to a repairing depôt for structural repairs, or for the conversion of dead buffers to spring buffers, ¾in. bolts must be fitted through the spring shoes when this is practicable without alteration of the springs.

Shackle and pin couplings are to be discarded as from the 31st December, 1905, and replaced by three-link draw-chains of the dimensions given in the standard specification for new wagons.

Inspection.

Every dead-buffered wagon converted to spring buffers to be inspected and passed before being allowed to go into



traffic, and a register plate of the following design to be affixed to each side thereof :—

The plate so affixed will pass the wagon to work over the company's or any other line of railway without further registration.

Appendix to Foregoing Specification.

Examination and Tests of Bearing and Buffing Springs.

27. The bearing and buffing springs must be of the best workmanship, and well tempered; the inspector will examine the springs as manufactured, and shall reject any he may consider defective in material or workmanship, or that do not stand the following tests :—

(*a*) Each bearing spring to be brought back under the scrag until the plates are within 1¼ins. of being straight for springs with ½in. plates, and within 2½ins. of being straight for springs with ⅝in. plates, and then to resume its original cambre; the back plate, when detached from the rest of the spring after scragging, to stand up within 5 per cent. of the specified cambre for the finished spring.

(*b*) Each buffing spring to be brought back under the scrag quite straight, and then to resume its original cambre; the back plate, when detached from the rest of the spring after scragging, to stand up to within 5 per cent. of the specified cambre for the finished spring.

(*c*) Each spring to be scragged through the buckle, and the inspector to be allowed an opportunity of examining the parts before the buckle is put on. For bearing springs nothing below, or ¼in. above, specified cambre will be allowed. For buffing springs nothing below, or ⅜in. above, specified cambre will be allowed.

(*d*) The hoops to be made of good fibrous bar iron of such quality as to have an ultimate tensile strength of not less than 22 tons or more than 24 tons per square inch, with an elongation of not less than 22 per cent. measured over a parallel length of 8ins., and to admit of bending when cold without cracking as follows :—

¾in. thick through an angle of 22 degrees.
⅝in. ,, ,, ,, 27 ,,

Finished hoops will be selected by the inspector at the rate of 1 per cent. for testing to destruction in the following manner :—

Taper blocks to be forced through the cold hoop, straining the metal both in sides and ends. Should the hoop selected part at the weld, or break in an unsatisfactory manner, other hoops up to 5 per cent. shall be taken, and the bulk represented passed for use if the fractures are to the inspector's satisfaction.

(*e*) All springs made to the same drawing to carry uniform loads with the same deflection.

Testing of Steel Tyres and Axles.

28. (*a*) The maker shall provide, at his own expense, one additional tyre and one additional axle in every fifty, to be selected from the bulk by the inspector, for testing in the manner described below. In the case of a less number than 15 axles being ordered or made from one cast, an end to be left on one axle from each ingot, of the same diameter as the forged end, to enable the inspector to stamp one, from which test pieces may be cut for the tensile test and cold bend test as specified. The tyres, axles, or ends so tested shall be given up to the buyer if required.

(*b*) The tyres and axles tested to be held to represent correctly the quality of the lots from which they are taken.

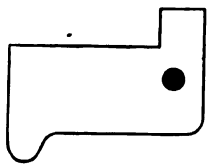
(*c*) Each tyre and axle to be stamped, while hot, with the day, month and year when made.

(*d*) The maker's name and also blow or cast number to be well stamped upon each axle, and on the outer edge of each tyre.

29. (*a*) No tyre to have a diameter of less than 3ft. 1in. on the tread, and each to be guaranteed to stand the following tests without re-heating or any other manipulation whatever, either of the tyre selected for testing or of any portion cut therefrom to furnish the tensile test piece.

(*b*) Falling Weight Test.—The tyre placed in running position on a solid foundation and subjected to repeated blows of a 2,240 lbs. tup, falling from a height of 10ft., 15ft., 20ft., 25ft., and upwards, must deflect without fracture 1in. for every 8ins. of the internal diameter—the blows to be continued until the tyre is doubled up or broken, or, at the option of the inspecting engineer, the tyres may be compressed by hydraulic pressure to the same figures.

(*c*) Tensile Test.—A test piece ½ sq. in. area, machined cold from each tyre in the position shown in the marginal sketch, and which has been subjected to the falling weight test, must have an ultimate tensile strength and elongation as follows :—



	Ultimate tensile strength in tons per square inch.	Minimum elongation measured over parallel length of 3 inches.
Class A	35 to 40	25 % to 20 %
Class B	42 to 48	18 % to 14 %

(*d*) In the event of the representative tyre not satisfying the foregoing requirements, the inspector is to be permitted to make further tests of tyres, also provided by the contractor at his own expense, before finally refusing or accepting the tyres represented.

Should the tyre fail in the falling weight or compression test, two more tyres may be taken from the same cast for testing.

Should the tyre fail in the tensile test, and the fractured test piece indicate that the result does not fairly represent the bulk of the tyres, a second tensile test piece will be taken from the same tyre together with a third test piece, to be prepared from another tyre (selected by the inspector), which shall have endured the falling weight test. The tyres will be accepted if two of the three test results are satisfactory. Tyres which fail to pass the tests under Class B may be resubmitted under Class A.

All tyres rejected for failure in test shall be destroyed in the presence of the inspector.

Ringing Test.—When specially required each tyre to be raised to a height of 5ft. and allowed to drop freely upon a rail fastened to an iron block of not less than 2 tons weight, and afterwards to be turned round through an angle of 90 degrees and dropped a second time through the same height.

Each axle to be guaranteed to stand the following tests :—

(*g*) Falling Weight Test.—Five blows without fracture from a weight of 2,240 lbs. falling from a height of 20ft. upon the axle for 10-ton wagon axles, or 21ft. for 12-ton wagon axles, placed upon bearings 3ft. 6ins. apart. The

axle to be turned after each blow. After being tested the axle to be broken.

(*h*) Tensile Test.—A test piece of ½ sq. in. area cut from any part of the axle tested, or from the ends left on the forgings, to give an ultimate strength of not less than 35 tons nor more than 40 tons per sq. in., with an elongation measured over a parallel length of 3ins. of 25 per cent. for 35 tons and 20 per cent. for 40 tons, the intermediate elongation being in proportion.

(*i*) Cold Bend Test.—A bar 9ins. long and 1¼ins. sq., $\frac{1}{16}$in. radius at the corners, to be bent through 90 degrees round a bar 2½ins. diam. and the ends brought together without fracture. This test will be taken only when a less number than 15 axles are ordered and the falling weight test (*g*) has not been carried out.

(*j*) In the event of the representative axle not satisfying the foregoing requirements, the inspector is to be permitted to make further tests of axles, also provided by the contractor at his own expense, before finally refusing or accepting the axles represented.

Should the axle fail in the falling weight test, two more axles will be taken from the same cast for testing.

Should the axle fail in the tensile or bend test and the fractured test piece indicate that the result does not fairly represent the bulk of the axles, a second test piece will be taken from the same axle together with a test piece to be prepared from another axle, selected, by the inspector, which shall have endured the falling weight test. The axles represented will be accepted if two of the three test results are satisfactory.

All axles rejected for failure in test shall be destroyed in the presence of the inspector.

Testing of Wrought-Iron Axles.

30. (*a*) Falling Weight Test.—Five blows without fracture from a weight of 2,240 lbs. falling from a height of 18ft. upon the axle for 10-ton wagon axles, or 20ft. for 12-ton wagon axles, placed upon bearings 3ft. 6ins. apart. The axle to be turned after each blow. After being tested the axle to be broken.

(*b*) Tensile Test.—A test piece of ½ sq. in. area cut from any part of the axle tested, or from the ends left on the forgings, to give an ultimate strength of not less than 22 tons per sq. in., with 25 per cent. elongation measured over a parallel length of 3ins.

(*c*) Cold Bend Test.—A bar 9ins. long and 1¼ins. sq., $\frac{1}{16}$ in. radius at the corners, to be bent through 90 degrees round a bar 2½ins. diam., and the ends brought together without fracture. This test will be taken only when a less number than 15 axles are ordered and the falling weight test (*a*) has not been carried out

(*d*) In the event of the representative axle not satisfying the foregoing requirements, the inspector is to be permitted to make further tests of axles, also provided by the contractor at his own expense, before finally refusing or accepting the axles represented.

Should the axle fail in the falling weight test two more axles will be taken from the same lot for testing.

Should the axle fail in the tensile or bend test and the fractured test piece indicate that the result does not fairly represent the bulk of the axles, a second test piece will be taken from the same axle together with a test piece to be prepared from another axle selected by the inspector, which shall have endured the falling weight test. The axles represented will be accepted if two of the three test results are satisfactory.

All axles rejected for failure in test shall be destroyed in the presence of the inspector.

Specification for Iron and Steel Plates and Bars.

1. All iron plates and bars to be of such quality as to have an ultimate tensile strength of—

	Tons per square inch.	Elongation in 8ins.
Round and square bars, and flat bars less than 6ins. wide ...	22 to 24	22%
Angle, Tee, Channel and H bars, and flat bars over 6ins. wide...	22 ,, 24	14%
Plates with the fibre	22 ,, 24	12%
Plates across the fibre	18 ,, 20	5%

All bars to be bent both when hot and when cold through 90 degrees round a bar 2½ ins. diam., and the ends brought together without fracture.

Plates when hot to admit of bending round a radius equal to their thickness through an angle of 125 degrees with the grain and 100 degrees across the grain, and when cold as follows:—

Thickness in inches.		Plates to bend through an angle of			
1 and $\frac{15}{16}$	...	15°	with the grain	5°	across the grain.
$\frac{7}{8}$,, $\frac{13}{16}$	...	20°	,,	7°	,,
$\frac{3}{4}$	...	22°	,,	10°	,,
$\frac{11}{16}$	..	25°	,,	10°	,,
$\frac{5}{8}$	...	27°	,,	12°	,,
$\frac{9}{16}$	...	30°	,,	12°	,,
$\frac{1}{2}$	...	35°	,,	15°	,,
$\frac{7}{16}$	...	42°	,,	17°	,,
$\frac{3}{8}$	...	50°	,,	20°	,,
$\frac{5}{16}$	...	60°	,,	25°	,,
$\frac{1}{4}$	...	70°	,,	30°	,,

2. The steel plates and bars to be of the quality of material generally known as mild steel. The manufacturer to supply full analysis when required to do so. The ultimate tensile strain that the material will stand to be not less than 25 or more than 30 tons per sq. in., with an elongation of not less than 22 per cent. in 8ins. when the thickness of the sample is more than $\frac{5}{16}$ in., and at least 20 per cent. when the thickness is $\frac{5}{16}$ in. or less.

Strips 1½ins. wide when cold, heated uniformly to a low cherry red and cooled in water of a temperature of about 80 degrees Fahr., to stand bending in a press to a curve, the inner radius of which is equal to the thickness of the plate.

3. All plates and bars to be clean rolled truly to a uniform thickness and to be perfectly free from defects.

4. The inspector to have free access to the manufacturer's works at all reasonable times during the course of manufacture, and to be at liberty to inspect any of the plates and bars, whether finished or in course of manufacture, and to carry out the above tests, or any other bending or drifting tests he may consider necessary. He shall be at liberty to select samples at the rate of 2 per cent. from each batch of finished plates or bars, or he may attend at the works at the time of rolling and test the crop ends.

Further drawings showing the details of these wagons will be published in a future issue.

Wooden Sleepers.—I.

INTRODUCTION.

CONSIDERING the enormous quantity of sleepers used in the permanent way of the railways of the world, the number and the magnitude of the depôts where sleepers are made and prepared, and the importance of the question in the economy of railway construction and maintenance, it seems remarkable that no serious attempt has yet been made to collect such information as is available and to place it in book form for the easy reference of the railway engineer. Many books have been written on far less important matters, but the engineer of permanent way has to collect his information from a multitude of sources, from elementary works on general civil engineering, where the matter is dealt with summarily in one or two chapters, from books on the permanent way of railways, where the subject is considered in perhaps only one chapter, from periodical journals where the question is referred to generally as a mere detail or appanage of the main subject of railway track, or from papers read before Institutions or Societies of Engineers, in which the subject of the sleepering of railways is incidentally referred to, but which no engineer appears to have considered of sufficient importance to warrant the preparation of a paper solely and independently to deal with, except one or two papers of a general character read to American societies. The records and literature on the subject may possibly be correctly described as voluminous, but no separate treatise appears to have been published on the question.

Timber is ever becoming scarcer and more expensive, and at the same time is being adopted for many purposes where it has not been used before. Forests are not being replenished as they are cut down, and as population increases and trade expands the available supply will even through these causes consequently decrease. The greater facility given by railways for the transit of timber from the forests may tend to cheapen the production of sleepers, but the distance through which the timber has to be brought is always increasing also.

The first railways that were built in some localities ran through unlimited quantities of good timber, and the value of the timber in these cases was almost entirely nominal, since it had to be removed in any case, and as there probably were no roads other than the railway, and the country was not yet settled on, there was possibly no other outlet for the disposal of the wood that must be cut down. In this condition of affairs of course no one thought of preserving the timber by any course of antiseptic treatment, since the whole operation would have been absurdly expensive, and the timber would have had to be taken to and brought back from the pickling depôt, it not being practicable to take the depôt to the timber. The wood under these conditions was cut and shaped and laid down for the sleepers of the railway without any preparation whatever.

This, however, did not continue long. The sleepers so laid did not last more than two or three years, especially in bad climates, and each of them had to be replaced by sleepers hauled by wagon from a distance, the cost, of course, increasing at once with the greater labour involved.

The question of the preservation of the wood so that it would last longer than in an unpreserved condition now became pressing, and the various methods of preservation were at once discussed and tried by engineers. Inferior and cheaper qualities of wood were used in some cases, but as these sleepers were much more easily abraded and injured and liable to decay, the question of artificial preservation became of even greater importance.

It is said that the forests in America are depleted to the extent of 1,800 square miles of timber annually for railway sleepers alone, and this does not include the large amount of wood used for piles and timbers of bridges and stations. In America alone the annual consumption is nearly 100,000,000 of sleepers for renewals and for new work.

This will give some idea of the importance of the subject of the conservation of forests to the governments of various countries, a consideration important for the benefit of posterity even if not imperative for the advantage of the present population of those lands.

The present and future supply of wood for sleepers must be carefully considered by any railway company before it lays down any extensive plant for the creosoting or other preservation of timber. In some countries the purchase of large tracks of forest has to be undertaken, and these must be large enough to yield an efficient annual supply for at least so long a time or number of years that the expenditure on the creosoting may be justified. In other conditions contracts may be entered into in which the same conditions of supply will have to be considered.

The initial desideratum in railway sleepers is that the "first cost" shall not be too great for the economical allocation of the capital to be expended on the line, and that the renewal of the sleepers, which must inevitably occur every ten to twenty years, must not be too expensive an operation. It is very poor economy to use sleepers of a wood that is only cheap and has not the other necessary qualities. The cost of laying down the sleepers is the same in any case, but some cheap woods give indifferent service and also require more frequent attention. In this case of course the cost of maintenance and renewals costs much more and the disturbance to the traffic is increased, it being more difficult to preserve a good running road. In this consideration of first cost it will be seen that a sleeper that has to be brought a long distance at great cost is out of the question, and the same difficulty will occur if the preparation of the material involves too great an expense.

Not only is this to be taken into account, but the ease of laying and the rapidity with which the material can be handled forms an important item also. A sleeper difficult to handle, or which necessitates the employment of a large gang, and which can only be placed in position for doing its work very slowly, is out of the question.

A satisfactory sleeper must at the same time be of such a description that the maintenance after it is laid shall be as easy as possible. It must be of such a pattern that it can be rapidly adjusted and packed to its true position by a small gang of men working with ordinary tools, and it must not be of such a size, weight, or shape that it will readily change its position under quickly moving loads.

It is imperative that the sleeper shall be of such a description that it shall conduce to good and easy "running," it should be able to quickly absorb and annul the vibration of the engines and other vehicles, and it should not be of such a nature that it will pound or wear down the ballast in which it is placed and so destroy the effectiveness of the ballasting material and transform it into clouds of dust.

A good sleeper must not feel too greatly the influence of climate upon it. If it is placed in dry surroundings it must not be liable to too easy destruction by rot, cracks, or insects; and if it is placed in a wet country it must not be liable to succumb to decay, warping, shakes, or other of the too common defects.

Finally, it should not be too easily destroyed in the case of accidents, and it must possess general "handiness" if it is required to put it to any temporary use, such as for trestling, for fencing, and in some cases even for temporary buildings.

Of course it does not necessarily follow that because sleepers are carried long distances that they cannot be economically used; indeed, as a matter of fact most of the sleepers used in Great Britain are brought from very distant ports, even so far away as Australia, America, and the Colonies. But such material must be delivered at compartively a cheap rate and in good condition upon arrival. The carriage of sleepers in many countries does, however, matter considerably, especially for the construction of new lines, and in such cases it may be economically far more preferable to adopt local timber, even of an inferior class, than to use material that has to be brought a long distance and conveyed overland at great cost and with much trouble.

Varieties and Description of Woods used for Sleepers.

Many descriptions of wood are used for railway sleepers. Soft woods are adopted in several of the northern countries of Europe, the pine, the fir, and other conifers; but where such is more economical oak, beech, and other hardwoods are extensively used. Baltic pine (Pinus sylvestris) is the wood generally used in Great Britain, and it has also been sent out to some of the lines in South Africa. The names "pine" and "fir" are sometimes used indiscriminately, but correctly speaking they are of very different kinds of wood. Both are of the same order, Coniferæ, and sub-order Abietineæ, but fir is of the genus Abies, whilst pine is of the genus Pinus.

The genus Pinus includes both the Scotch pine and the cluster pine. The Scotch pine (Pinus sylvestris) is known as "redwood," and also is designated with the name of the locality from which it is shipped, as Riga, Dantzig, Baltic, or as Swedish, etc. It is a tree that flourishes exceedingly well in cold countries and provides a much firmer and stronger wood when grown in these latitudes than its allied species do when grown in warmer climates.

Of much the same species are the Corsican pine, otherwise known as Pinus Laricio, or Calabrian pine. The Austrian Baltic pine, variation Austriaca of the Pinus Laricio, and the Pinus Halepensis, or Aleppo pine, are also allied. An entirely different variety is the Pinus Australis or pitch pine, a resinous wood much used for ship building.

The cluster pine (Pinus Pinaster) grows well on the sandy soil of Central Europe, and is known under its other names of maritime pine, star pine, and Landes pine. Before this wood is used for constructional work the resin is removed for the making of turpentine, but when it is used for railway sleepers it is not quite decided whether the resin should be removed or not.

The genus Abies provides the firs, perhaps the most well-known being the silver fir (Abies pectinata). The spruces (genus Picea) are very like the firs, and the hemlock (genus Tsuga) much resembles them.

Railway sleepers are also made from the Norway spruce (Picea excelsa) and the common larch (Larix Europæa).

Oak (Quercus) is generally used where special sleepers are required for extraordinary purposes.

The two well-known Australian woods, Jarrah and Karri, have been used to some extent as railway sleepers, and should be very successful if their use as paving for streets is any criterion. Their great comparative weight must be in their favour, for the "easy running" of the railway and also in the sense of stability.

The Quebracho Colorado grown in the Argentine Republic is very well spoken of as being superior to many other woods used for sleepers. It is said to be worked almost as easily as the ordinary European woods, but yet to possess the weight qualification so necessary for this purpose. The density is given as 1·39 for this wood to 1·01 for oak and 0·50 for fir, and its weight as 80lbs. to the 40 to 60lbs. of oak and the 30 to 35lbs. of fir. Its tensile and compressive strength is also said to exceed that of the other two woods.

Teak is used in Holland, eucalyptus in New South Wales and South Africa, and in Belgium oak sleepers are in general use.

Most of the different kinds of woods named are creosoted or pickled in one way or other except the heart of oak. Beech (Fagus) is sometimes pickled with chloride of zinc, but is not generally creosoted. Pine and fir are nearly always pickled with creosote, and if not with this, cupric sulphate or zinc chloride are used. In some cases an emulsion, generally consisting of a mixture of creosote and an aqueous solution of a salt, is used with success.

Creosoted pine from Europe is used on the Indian railways as well as indigenous woods, such as deodar, teak, and sal. In that country the white ants will speedily make away with European woods, but they will not attack either pyingado or teak. The average life of the deodar may be taken to be 12 to 15 years, or from this up to 25 years in exceptional cases.

The question of carriage has an important bearing on the economic choice of the wood. In many cases it is cheaper to bring the sleepers from Europe if they have not to be taken far up into the country than it is to carry native woods a long distance by manual labour, perhaps hundreds of miles from the hills where the trees are cut down. Pyingado comes from Burmah, but seems to last longer in its own country than in the hotter and drier plains of India. The question of ballast has an important bearing on the use of deodar in India; with sand as ballast the life is not more than 8 years.

More than one half of the sleepers used in the United States of America are of oak, but pine sleepers amount to one quarter of the whole, and the remainder are made up of cedar, chestnut, hemlock, tamarack, cypress, redwood, and other woods.

White oak is very durable and not liable to rot, its average life being from 8 years in the Southern states to 12 years in the North. It is excellent for wear, and fails usually rather by decay than by mechanical means. The part embedded in the ballast is the first to be affected by decay.

Burr or rock oak and chestnut oak are not quite so good as the white oak and have a shorter life of about 6 to 10 years, whilst black, red and yellow oak are nothing like so good and have a yet shorter existence under traffic of from

4 to 5 years. Water oak is still more inferior, and will only last about 4 years.

Yellow and white pine are much better for railway sleepers than the other varieties, and although they may be classified as soft timbers, still they are slow to decay, and their life may be taken as 6 to 10 years, according to the traffic upon them. Southern pitch pine will last from 5 to 7 years, and both this and the short leaf yellow pine are not so good as the previous descriptions, the short leaf yellow pine lasting about 4 to 5 years. The wood is not so hard as the Baltic fir used in European countries, probably on account of the timber being grown in a warmer climate.

For some purposes in bridge work yellow pine is preferable even to oak, as it does not warp and twist to anything like the same amount. Spruce pine is also used for wooden sleepers to some extent, is more durable than certain varieties of oak, and is better for holding the spikes that fasten down the rails.

White chestnut is nearly equal to oak in wear, and is even better as regards freedom from decay; but under heavy traffic the timber cuts badly. The decay in this timber when it occurs is generally above the ballast and not underneath it, as in the case of oak. The tendency to split is, however, noticeable in this wood, and makes it less desirable to use.

Red and white cedar are good timbers for sleepers, and last from 9 to 15 years, but this timber will cut under the rails as in the case of chestnut. Neither chestnut or cedar hold the spikes so well as other timbers.

Hemlock is not so good as the previously named woods, and has a life only of 4 to 8 years, but the first cost in many localities is small, and for this reason only is the wood adopted for use in the first construction of railways. It soon becomes soft under the traffic and the spikes wear loose.

Spruce is much the same as the above, with a life of 5 to 9 years. Tamarack of hackmatack (otherwise known as larch) is of frequent use and has a life of 5 or 10 years.

There is an abundant supply of black and red cypress in the Southern states, and the wood is durable, although it is soft and requires distributing plates between it and the rails above.

Redwood is soft and cuts badly under the rails, but yet it is very durable if the weight is effectively distributed upon it. Black redwood is a fine timber, but is only used in the Pacific states.

Black and honey locust and black walnut and catalpa woods are good, but these varieties are not very easily obtained.

Beech is a fine hard wood, but will quickly rot unless it is treated with an antiseptic before it is laid down. Elm and cherry are of the same nature, but cherry is found to split easily.

Maple, hickory, ash, birch, butternut and white beech are not durable and are little used, as is the case also with sassafras, mesquit, and mulberry.

(To be continued.)

Railways and the Board of Trade.—VI.

(Concluded from page 211).

Continuous Brakes.

The Board of Trade, in accordance with the Railway Returns (Continuous Brakes) Act of 1878, are supplied with returns as to the mileage run and number of failures of continuous brakes.

The details include :—

Number of engines belonging to the railway.
Number of vehicles belonging to the railway.
Percentage of total stock complying with the requirements of the Board of Trade.
Engines fitted with brake.
Engines fitted with apparatus for working the brake.
Carriages, &c., fitted with brake.
Carriages, &c., fitted with pipes.
Mileage run by trains fitted.
Proportion of vehicles fitted with brakes.
Proportion of mileage run by trains fitted.
Details of all failures or partial failures to act in case of accident or imminent collision.
Details of all failures or partial failures to act under ordinary circumstances.
Number of miles run by trains with each description of brake.

The particulars of the so-called failures are a farce. They appear in the "blue books" as given to the companies by the drivers, and thus for example we have the Board of Trade seriously recording burst vacuum hose-pipes as brake failures.

Workmen's Trains.

The Board of Trade come into contact with railways in connection with workmen's cheap trains. It acquired this power under the Cheap Trains Act, 1883, which says :—

If at any time the Board of Trade have reason to believe (*a*) that upon any railway or part of a railway, or upon any line or system of railways, whether belonging to one company or two or more companies which form a continuous means of communication, a due and sufficient proportion of the accommodation provided by such company or companies is not provided for passengers at fares not exceeding a rate of one penny per mile, or (*b*) that upon any railway carrying passengers proper and sufficient workmen's trains are not provided for workmen going to and returning from their work, at such fares and times between six o'clock in the evening and eight o'clock in the morning, as appear to the Board of Trade to be reasonable, then, and in either case, the Board of Trade may make such enquiry as they think necessary, or may, if required by the company, or any of the companies concerned, refer the matter for decision to the Railway Commissioners, who shall have power therein as if it had been referred to their decision in pursuance of the Regulation of Railways Acts, 1873.

From the passing of the Act of 1883 to 1903 there had been 49 applications addressed to the Board of Trade as to workmen's cheap train. Most of these were since 1895. Late in the Session of 1903 a select committee was appointed to consider this question. They were re-appointed in 1904, and as their labours have not yet been completed they have asked to be re-appointed in 1905.

Further action as regards this matter is therefore likely.

Hours of Labour.

The next subject wherein the Board of Trade touch railways has reference to hours of labour. There are two Acts of Parliament which refer to this matter.

The first is the Act of 1889 relating to the Regulation of Railways. It states :—

"Every railway company shall make to the Board of Trade periodical returns as to the persons in the employment of the company whose duty involves the safety of trains or passengers, and who are employed for more than such number of hours at a time as may be from time to time named by the Board of Trade.

"The returns shall be delivered at such intervals and shall be in

Nos. I., II., III., IV. and V. appeared in *The Railway Engineer* for January, February, March, May, and July, 1905, respectively.

such form and contain such particulars as the Board of Trade from time to time direct."

Returns were asked for by the Board of Trade for the months of December, 1901, and December, 1902, of the members of certain classes of servants whose hours had exceeded 12 hours per day during that month, and who, after such hours of duty, had resumed work after an interval of rest of nine hours. A similar return was asked for for October, 1903, which is a fairer month than December, when there is necessarily a large amount of overtime due to the Christmas traffic.

The second and more important piece of legislation was the Act of 1893. It states :—

1. If it is represented to the Board of Trade by or on behalf of the servants or any class of the servants of a railway company that the hours of labour of those servants, or of that class, or in any special case, of any particular servants engaged in working the traffic on any part of the lines of the company, are excessive or do not provide sufficient intervals of uninterrupted rest between the periods of duty or sufficient relief in respect of Sunday duty, the Board of Trade shall enquire into the representation.

2. If it appears to the Board of Trade, either on such representation or otherwise, that there is, in the case of any railway company, reasonable ground of complaint with respect to any of the matters aforesaid, the Board of Trade shall order the company to submit to them within a period specified by the Board such a schedule of time for the duty of the servants, or of any class of the servants, of the company, as will, in the opinion of the Board, bring the actual hours of work within reasonable limits, regard being had to all the circumstances of the traffic and to the nature of the work.

3. If a railway company fail to comply with any such order, or to enforce the provisions of any schedule submitted to the Board in pursuance of any such order and approved by the Board, the Board may refer the matter to the Railway and Canal Commission, and thereupon the Railway and Canal Commission shall have jurisdiction in the matter, and the Board may appear in support of the reference and the commissioners may make an order requiring the railway company to submit to the commission, within a period specified by the commission, such a schedule as will, in the opinion of the commission, bring the actual hours of work within reasonable limits.

4. If a railway company fail to comply with any order made by the Railway and Canal Commission in pursuance of this section or to enforce the provisions of any schedule submitted to the Railway and Canal Commission in pursuance of any such order and approved by that commission, the company shall be liable to a fine not exceeding £100 for every day during which the default continues.

5. The Railway and Canal Traffic Act, 1888, shall apply in the case of any jurisdiction exercised or any order made by the Railway and Canal Commission under this Act as if it were exercised or made under or for the purposes of that Act; provided that notwithstanding anything in Section 5 of that Act the jurisdiction of the commission for the purposes of this Act may be exercised by the two appointed commissioners.

6. The Board of Trade and the Railway and Canal Commission respectively may, from time to time, rescind or vary any order made by them under this section, and make such supplemental orders as the circumstances of the case may appear to require.

7. This Act shall not apply to any servant of a railway company who is in the opinion of the Board of Trade wholly employed in clerical work or in the company's workshops.

The Board of Trade were careful when making enquiries as to a complaint not to ask for information as to a particular place or the complainant might be identified. They asked for information as to a certain section of the line or certain stations.

The questions were numerous. For instance, if a signalman complained, information would be required as to the number of trains passing during the 24 hours, how many lines of way he had to attend to, what shunting was done, were any telegrams or telephone messages to be dealt with, and if he attended to level crossing gates what amount of vehicular traffic there was.

During the year ending July 27th, 1904, there were 11 cases dealt with, in 5 of which the Board of Trade state that the facts disclosed did not appear to show sufficient grounds for further action.

That there was need for legislative action is shown by the fact that in the 7½ years ending June, 1896, there 59 cases where the inspecting officers in their reports on railway accidents referred to long hours worked by some of the men concerned in those accidents.

That the Act has done good is proved by the last annual return, which is as follows :—

COMPLAINTS TO JULY 27TH.

Class of Servant affected.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total.
Signalmen	24	60	33	31	17	13	13	7	11	13	6	228
Drivers and Firemen...	14	22	12	2	5	11	8	4	38	9	1	126
Staff at Stations ...	14	30	20	20	14	5	5	3	3	2	1	117
Guards and Brakesmen	7	25	14	10	7	4	5	3	58	2	1	136
Shunters	6	12	9	10	5	8	7	1	6	1	1	66
Wagon Examiners ...	1	2	5	1	2	2	1	—	2	—	—	16
Gatekeepers	4	2	3	1	—	1	1	—	1	1	—	14
Platelayers	1	—	1	—	—	—	—	—	—	—	—	2
Other Grades... ...	1	3	—	1	—	2	1	1	4	—	1	14
Total ...	72	156	97	76	50	46	41	19	123	28	11	719

And it must be remembered that the number of servants whose hours are dealt with upon any representation is often considerably larger than the number of servants referred to in the original complaint.

Accidents to Railway Servants.

All accidents to railway servants are now fully investigated.

In 1894 two qualified railway servants were appointed sub-inspectors to make enquiries as to accidents to railway servants, and in 1901 two assistant inspecting officers who had had railway experience were appointed. The latter enquire into the more serious accidents to the men.

During the year 1902 these four gentlemen held 560 enquiries, and in 1903 there were 607 enquiries.

The results of these enquiries and the recommendations of the officers are given in the blue books on railway accidents.

In the general reports for 1902 and 1904 these 560 and 607 enquiries are summarised as follows :—

	1902.	1903.
Misadventure or accidental...	114	140
Want of caution or misconduct on the part of the injured person	213	248
Want of caution or breach of rules, &c., on the part of servants other than the person injured	115	155
Defective apparatus or defects in permanent way, works, &c.	40	44
Want of appliances or safeguards or insufficient staff	19 }	19
Unsatisfactory system of working	51 }	
Non-observance of rules under the Railway Employment (Prevention of Accidents) Act, 1900	1	1
Doubtful causes	7	—

Whilst the number of railway servants killed and injured on British railways did not increase and it made an excellent comparison with the conditions in America, yet it was felt that greater safety could be obtained for them by the adoption of certain improved methods of working.

As a result the Railway Employment (Prevention of Accidents) Act of 1900 was passed, and in accordance therewith the Board of Trade introduced certain rules. After much discussion the following were approved on August 8th, 1902 :—

1. When it is necessary in the ordinary course of business

that any label or direction as to destination or consignee shall be placed upon any wagon, the company on whose line of railway such wagon is about to be used shall see that such label or direction is placed on both sides of such wagon. No railway company shall receive from any person for conveyance on its railway any wagon not labelled in accordance with this rule.

This rule shall not apply to mineral traffic in train loads for journeys not involving marshalling during or on the completion of the journey.

2. After the expiration of twelve months from the coming into operation of these rules, the movement of vehicles by means of a prop or pole, being the operation commonly known as "propping," shall not take place, except in cases where no other reasonably practicable means can be provided for dealing with the traffic.

After the expiration of the same period, tow-roping, that is to say, the effecting the movement of vehicles on a railway by means of towing with a rope or chain attached to a locomotive, or a vehicle moving on an adjacent line, shall not be allowed except in cases where no other reasonably practical means can be provided for dealing with the traffic.

The North Wales Narrow Gauge Railway Company is exempted from the operation of this rule, so far as relates to tow-roping.

3. All engines and tenders must, within two years from the coming into operation of these rules, be fitted with sufficient power brakes in addition to hand brakes.

Engines used exclusively for shunting purposes shall be exempted from the operation of this rule, provided that they are fitted with sufficiently powerful hand brakes.

4. All stations or sidings where shunting operations are frequently carried on after dark must be sufficiently lighted.

5. Where point rods and signal wires are in such position as to be a source of danger to persons employed on a railway whilst in the execution of their duty, such point rods and signal wires must, within two years from the coming into operation of these rules, be sufficiently covered or otherwise guarded.

Within the same period ground levers working points must be so placed that men when working them are clear of adjacent lines, and shall be placed in a position parallel to the adjacent lines, or in such other position and be of such form as to cause as little obstruction as possible to persons employed on the railway whilst in the execution of their duty.

6. All boiler gauge glasses on locomotive engines or on stationary steam boilers used in the working of railways must, within three years from the coming into operation of these rules, be protected by a covering or guard, sufficient to guard against accident to persons employed on the railway through the gauge glasses breaking.

7. All tool boxes used for the purpose of storing tools and other things necessary in the working of locomotives when running must, within two years from the coming into operation of these rules, be so arranged that the contents may be obtained by the men while the engine is in motion without undue risk of injury.

Water gauges or other devices must, within three years from the coming into operation of these rules, be provided on locomotive engines or tenders to indicate the amount of water in the tanks, and such gauges and similar devices shall be placed in such a position as to be visible and accessible to the men without their incurring undue risk of injury.

8. After the coming into operation of these rules, all trains working upon running lines beyond the limits of stations shall be provided with brake vans or other suitable vehicles for the use of men in charge of such trains, which shall be so attached as to be conveniently used by them and also with due regard to safety in working the trains.

The Festiniog Railway Company is exempted from the operation of this rule.

9. With the object of protecting men working singly or in gangs on or near lines of railway in use for traffic for the purpose of relaying or repairing the permanent way of such lines, the railway companies shall, after the coming into operation of these rules, in all cases where any danger is likely to arise, provide persons or apparatus for the purpose of maintaining a good look-out or for giving warning against any train or engine approaching such men so working, and the persons employed for such purpose shall be expressly instructed to act for such purpose, and shall be provided with all appliances necessary to give effect to such look-out.

10. In such cases where it is shown to the Board of Trade that for any sufficient cause the time within which any of the above rules and regulations have to be carried into effect should be extended, the Board of Trade may from time to time grant such extension upon such terms and conditions as they may think fit.

These rules shall commence and come into operation on the 8th day of August, 1902, and may be cited as the Prevention of Accidents Rules, 1902.

Financial Returns.

The last relation of railways to the Board of Trade to be noticed is the preparation of the annual statistics referred to in the Act of 1871.

It requires details of the authorised and paid up capital; amount raised by loans and debentures and the interest paid on each; the subscriptions to other companies; the mileage open (showing double and single road); number of passengers conveyed (each class); number of season ticket holders; tonnage of goods and mineral traffic and the mileage run by passenger and goods and mineral trains.

The receipts from passengers (each class and season tickets); from excess luggage, parcels, carriages, horses, dogs, &c.; from mails; from merchandise, live stock and minerals; also from rents, tolls, navigation, steam boats, &c.

Details are then to be given of the expenditure divided into maintenance and renewal of permanent way; locomotive power (including stationary engines); repairs and renewals of carriages and wagons; traffic charges (coaching and merchandise); general charges; rates and taxes; Government duty; compensation for personal injury; compensation for damage and loss of goods; legal and Parliamentary expenses; steamboat, canal and harbour expenses and miscellaneous.

The return to conclude with particulars of the rolling stock—locomotives, carriages used for the conveyance of passengers only, other vehicles attached to passenger trains, wagons of all kinds, other vehicles not included in the foregoing.

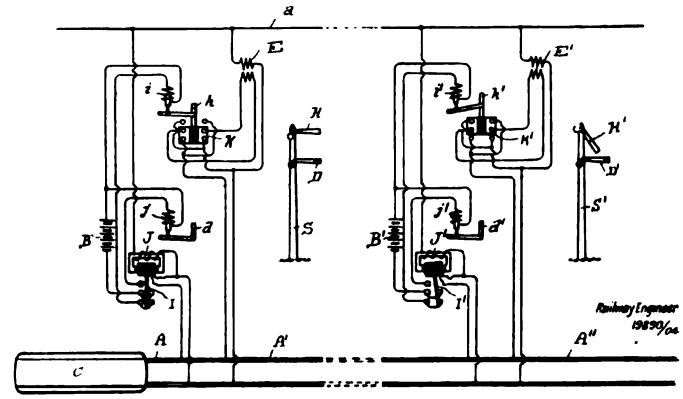
Recent Patents relating to Railways.

THESE abridgements of recently published specifications are specially compiled for this Review by Messrs. Wheatley and Mackenzie, Chartered Patent Agents, 40, Chancery Lane, W.C., from whom copies of the specifications can be obtained at an uniform price of 8*d*. each.

Electrical Block Signalling. *19,890. 15th September, 1904. The British Thomson-Houston Co., Ltd., 83, Cannon Street, London.*

Three blocks are represented at A, A^1, A^{11}. It will be seen that only one of the rails is divided into blocks, the other rail being continuous throughout all the blocks so as to serve as a return conductor for the power current. A line-wire *a* is connected to a source of alternating current and connected to the continuous rail through the primaries of the transformer E, E^1. With this arrangement the continuous rail acts as return conductor for the alternating current also, but a separate return conductor may be employed if preferred. S and S^1 represent two semaphore posts at the entrance to blocks A and A^1 respectively. Each post carries a home signal H and a distant signal D, the signals for the block A being the home signal H on semaphore post S, and the distant signal D^1 on semaphore post S^1. Thus, when a car is in block A, as indicated at C, signals H and D^1

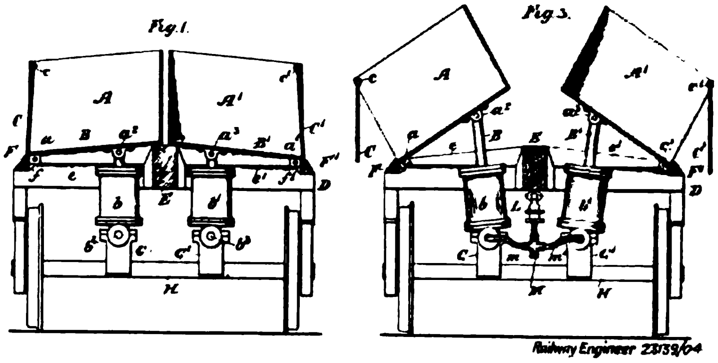
should be at danger, as shown; while signal H^1 is at safety position, since no car is in block A^1. The secondaries of transformers E and E^1 are connected to the blocks A^1 and A^{11} through reversing switches K and K^1. By means of these switches the phase of the currents in the rail circuits relative to the current in line-wire *a* may be reversed. To the other ends of the blocks are connected one winding of the relays J J^1, which are shown as of the wattmeter type with their movable windings connected to the block circuits. The other, or stationary, windings of the relays are connected directly between the line wire *a* and the return rail. The movable member of the relay carries a contact member I, which controls the two circuits of the two magnet coils *i* and *j*, which when contact member I is moved towards the left are both energised from the battery B, or other suitable source, while when the contact member I is moved towards the right only the winding *i* is energised. When member I is in the position shown the circuits of both magnet windings are open. This is the position which the contact member assumes either by gravity or a spring when the relay is de-energised. The magnet windings *i* and *j* control the rods *h* and *d*, respectively, which are the operating rods for the home signal H and distant signal D, respectively. The connections between these rods and the signals are omitted. The rod *h* also controls the phase-changing or reversing switch K. The phase-changing switch K controls the phase of the current in the block A^1, relative to the phase of the



current in line-wire *k*, as will be readily seen from tracing out the circuits of this switch. In other words the switch K controls the relative phases of the currents in the two members of the relay J^1. The operation is then as follows: with a car C in the block A the armature of relay J is short-circuited, the relay is consequently de-energised and assumes the position shown, thereby opening the circuits of both magnet windings *i* and *j*. Both signals H and D go to danger by gravity, indicating the presence of the car in the block. As signal H goes to danger rod *h* is moved downward to move switch K to the position shown. The relay J^1 has its movable winding energised with current in a direction, relative to that in line-wire *a*, determined by the position of switch K. The direction of current is such as to move contact member I^1 to the right, thereby closing the circuit of magnet coil i^1, while leaving the circuit of magnet coil j^1 open. Home signal H^1 is consequently drawn to safety position by magnet winding i^1, while the distant signal D^1 remains at danger. When car C leaves block A and enters the following block, relay J will be energised in the same manner as relay J^1, thereby closing the circuit of the magnet winding *i* and drawing home signal H to safety. This will remove the reversing switch K to its upper position, and reverse the direction of current through the block A^1, relative to the direction of current in line-wire *a*, thereby reversing the direction of torque in relay J^1. Contact member I^1 will be moved toward the left, closing the circuits of both windings i^1 and j^1, and signals H^1 and I^1 will consequently be drawn to safety, indicating that both blocks A and A^1 are clear. *(Accepted 7th September, 1905.)*

Tipping Wagon. *23,139. 27th October, 1904. W. H. McAlpine, of the firm of Robert McAlpine & Sons, 188, St. Vincent Street, and D. L. Smith, 294, West Princes Street, Glasgow.*

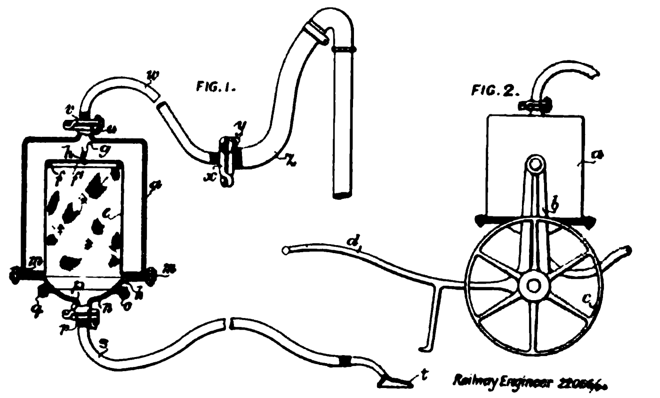
The wagon body is divided longitudinally into two parts, AA^1 forming separate receptacles, which are pivoted, and actuated from beneath by piston rods BB^1, operated by fluid pressure. The sides CC^1 of the receptacles are pivoted from c^1, and assume a perpendicular position when the receptacles are being



tipped. The inner sides of the receptacles are supported on a longitudinal beam E, carried by cross beams D at each end of the wagon. *(Accepted 31st August, 1905.)*

Dust Extractor for Cleaning Carriage Cushions, &c. *22,066. 13th October, 1904. T. W. Ford, Palace Chambers, 9, Bridge Street, Westminster.*

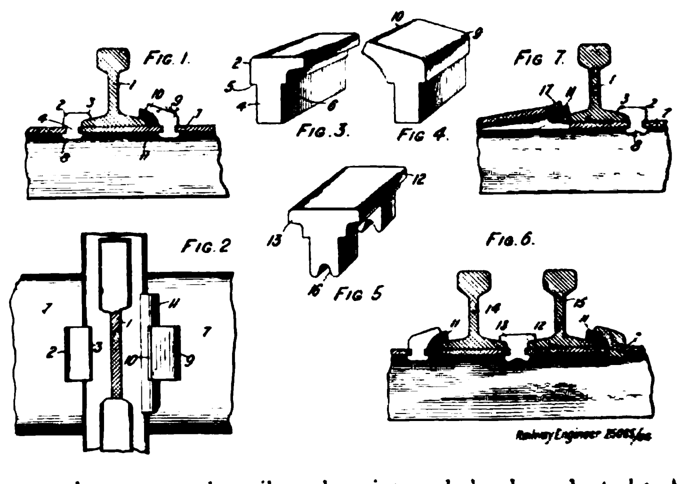
This apparatus is adapted to be connected to the vacuum brake pipe of a train, and consists of a portable vessel *a* containing a



dust-collecting sack or screen *e*, and a hose pipe *s* provided with a nozzle *t*, which is moved by hand over the surface of the cushion or carpet to be cleaned. *(Accepted 31st August, 1905.)*

Rail Fasteners. *25,085. 18th November, 1904. E. R. Calthrop, 3, Crosby Square, London.*

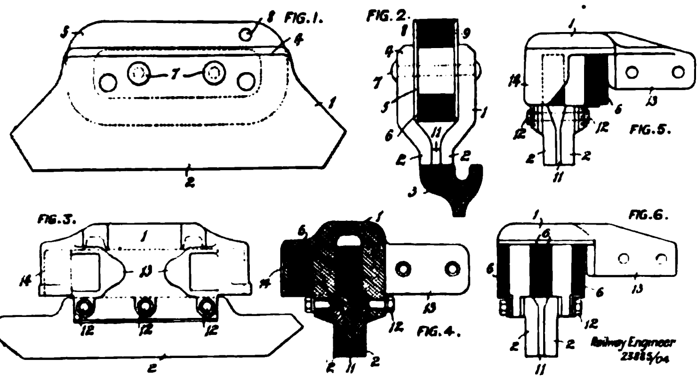
For securing rails to metallic sleepers, beds, or plate, a clip is provided, formed of a head having an outstanding edge 3 or 10,



arranged to engage the rail, and an integral shank 4 adapted to be passed through an aperture in the sleeper and rivetted on the under-side. A wedge 11 is driven in between the clip and rail flange. *(Accepted 14th September, 1905.)*

Magnetic Brakes. *23,885. 4th November, 1904. R. Braun, Westinghouse Works, Trafford Park, Manchester.*

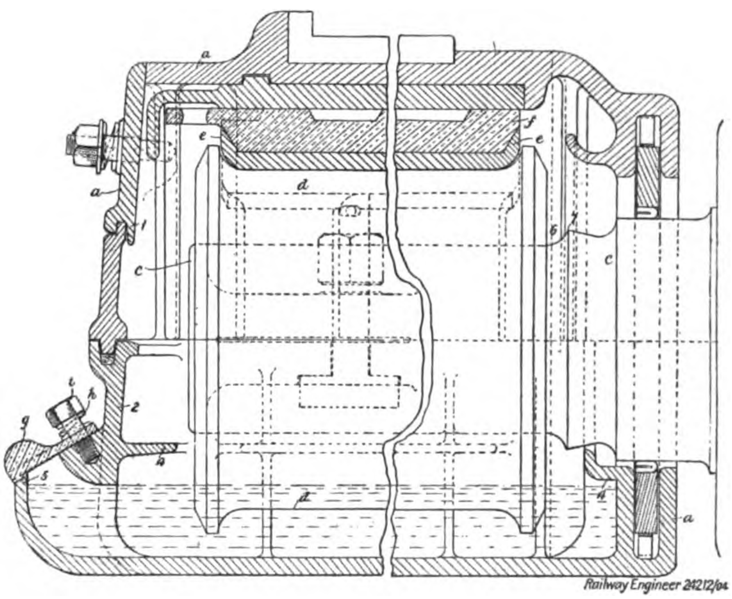
In brake shoes which form the poles of an electro magnet, the amount of the magnetic flux, and consequently the drag on the shoes, depends, among other things, upon the magnetic reluctance of the portion of the rail or wheel to which the shoe is applied. This invention provides an arrangement in which the reluctance of the magnetic circuit is very materially decreased, and this is attained by causing the magnetic flux to pass through the rail or



wheel not lengthwise as hitherto but across, whereby the effective area for the passage of the magnetic flux is increased whilst at the same time the length of the path is diminished. With this object in view shoes are provided for the electro-magnet, which extend side by side along the length of the rail or wheel whereby the magnetic flux is caused to pass in direction from side to side of the rail or wheel and is rendered more powerful than is obtainable at present with the expenditure of a given amount of energy. (*Accepted 31st August, 1905.*)

Axle Boxes. *24,212. 9th November, 1904. H. E. Lord, Brookfield Villa, 325, Birch Lane, Dukinfield, Chester.*

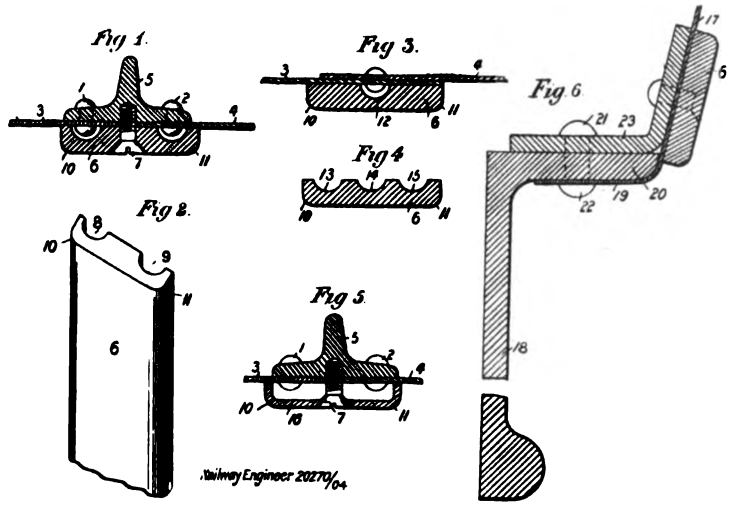
A flanged collar or sleeve *d* is fixed on the axle by hydraulic pressure, or shrinking, the sleeve and its flanges fitting against the lining *e* of the top bearing *f*. The outside diameter of the

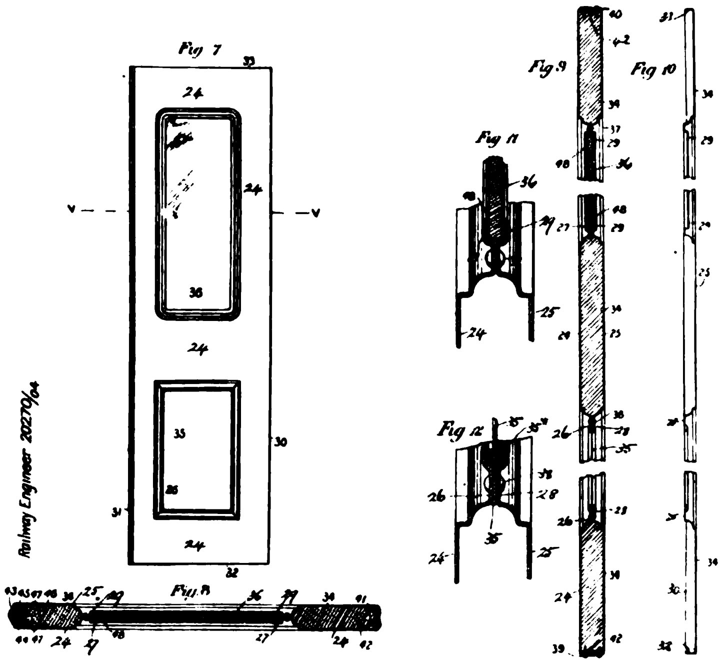


collar *d* is larger than that of the main axle in front of the wheel boss for the purpose of lubricating from an oil level which is lower than the hole in the back of the axle box. (*Accepted 7th September, 1905.*)

Railway Carriages and Tramcars. *20.270. 20th September, 1904. The Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd., Oldbury, Worcester, and A. E. Morgan, 112, Broadwell Road, Oldbury.*

This invention has reference more particularly to electrically propelled vehicles built of steel sheets or plates rivetted to a steel framework, and its object is to construct such articles so that they shall have practically the same appearance as if their bodies were built of wood in the usual way, and shall not be liable to excessive jar when in motion. According to one part of this invention, figs. 1 to 5, the rows of the heads of the rivets 1, 2, which secure the steel sheets or plates 3, 4, of the carriage or car body, to the bar 5 forming part of the framework, are hidden by a specially shaped rolled steel moulding bar 6 fixed over them as by screws 7 which pass through countersunk holes in the moulding bar and into the frame bar 5. The moulding bar 6 is by preference rolled to a flat shape in cross section with two longitudinal grooves 8, 9, on one side, of the proper size and distance apart to clear and enclose the two rows of rivet heads in the joint. On the other side of the bar the two corners 10, 11, are rounded off so that this bar may be fitted over the two rows of rivets and secured to the frame by suitable screws from the out-



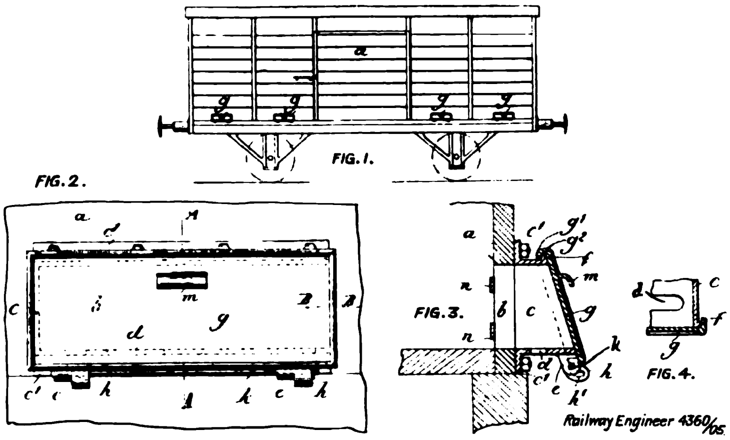


side. Where these moulding bars such as 6 meet at the corners of the panels or other parts they are mitred or otherwise fitted together so that when the carriage is painted and finished these mouldings have the same general appearance as the ordinary mouldings on the outside of the body of an ordinary railway carriage or tramcar. When only one row of rivets has to be covered by a moulding bar then the moulding bar is made with only one central groove 12 as shown by fig. 3 or when the moulding bar is required to cover three rows of rivets side by side then the moulding bar is made with three grooves 13, 14, 15, as in fig. 4. The lower edges of the sheets forming the outside panels are bent and fit against the underside of the flanges of the sole bars to which they are rivetted as shown in fig 6. The doors,

figs. 7 to 12, are each formed of two sheet metal stampings constituting the two sides of the door and made with raised flanged openings for the panels, a fireproof substance being fitted in the hollcw spaces between the stampings. The side walls of the vehicle and the roof are formed of sheet steel framing with sheet metal panels and a filling of asbestos. A covering or coating of non-inflammable cement is laid on the floor in a plastic or semi-fluid state and allowed to set. (*Accepted 14th September, 1905.*)

Wagons. *4,360. 2nd March, 1905. A. Spencer, 77, Cannon Street, London.*

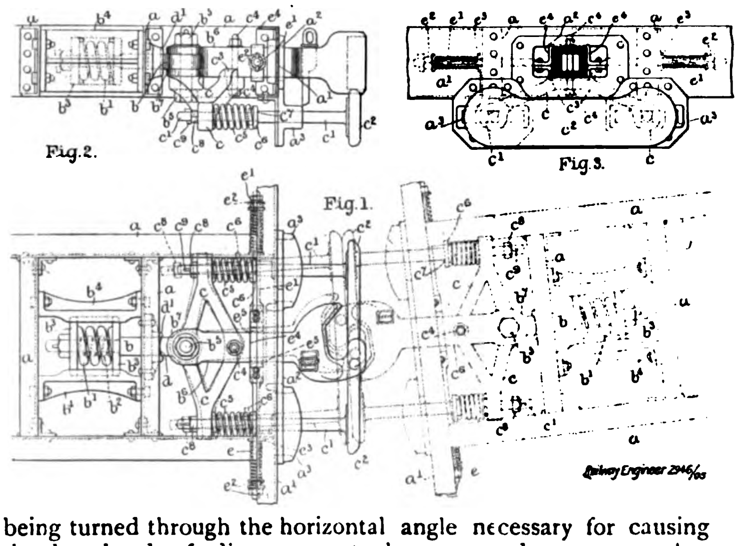
The object of this invention is to provide a wagon or truck that shall be readily adapted for carrying either cattle or goods. For this purpose a wagon is provided near its bottom or floor with combined inspection and ventilation passages, each of which is furnished with a movable cover adapted to close the outer end of the passage in a water-tight manner. The passage, however, is



always in free communication with the atmosphere, so that by placing the covers in their open positions the interior of the lower part of the wagon can be easily seen, the wagon or truck being then suitable for conveying cattle, whilst by moving the cover into its closed position the wagon or truck is suitable for carrying goods without danger of their being damaged by rain, sleet, hail or snow. (*Accepted 7th September, 1905.*)

Couplings (Automatic). *2,946. 13th February, 1905. E. J. Hill, 11, Victoria Street, and J. F. Robinson, 17, Victoria Street, Westminster.*

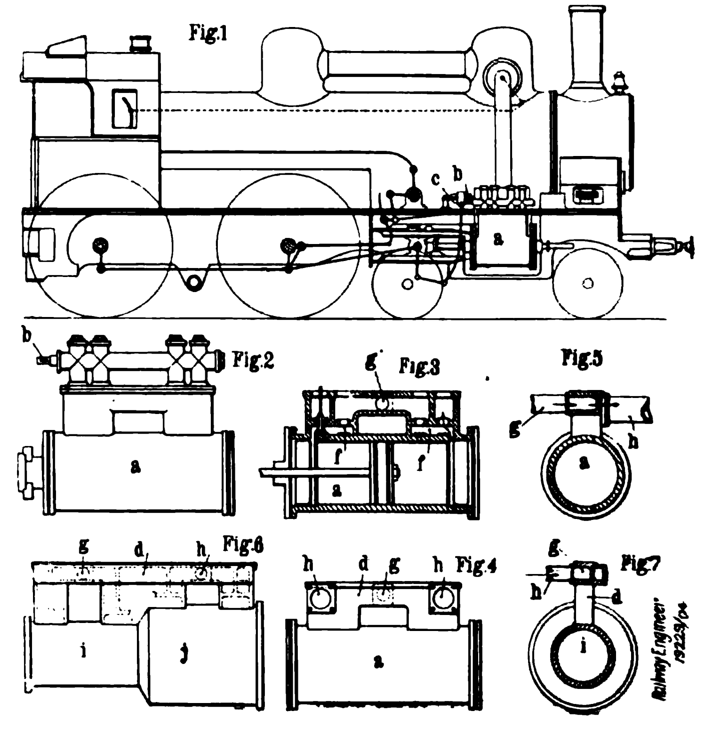
This invention relates to automatic couplings of the central-buffer type, and its object is to enable coupling to be effected when the vehicles to be coupled are on rails of sharp curvature. The draw-head is pivoted to the draw-bar so as to be capable of



being turned through the horizontal angle necessary for causing the draw-heads of adjacent cars to be presented to one another in their required mutual relation so that, whatever the radius of curvature of the rails, the mutually opposed draw-heads will be capable of being brought into alignment notwithstanding that their respective draw-bars lie at a considerable angle to one another. For the purpose of automatically causing the draw-heads to assume this position of alignment there is centered upon a pivotal connection between the draw-bar and draw-head a frame which extends laterally at each side of the draw-head and which projects to approximately the same distance as the latter beyond the head-stock of the car so as to form a "righting buffer" or automatic adjuster for the draw-head. The lateral extension of the frame is such that, whatever the curvature of the rails and the consequent angle between the draw-bars of adjacent cars, that portion of the one adjuster that is nearest the centre of the curve must, when the cars are brought togerher, encounter the corresponding portion of the opposed adjuster of the adjacent car, and consequently, when the cars are buffed up, the adjusters will turn about their pivotal connection with the respective draw-bars until the adjusters contact with one another across their whole width whi'st the draw-heads, moving as one with the adjusters, will be brought into alignment with one another, whereupon the coupling will be automatically effected as usual. (*Accepted 14th September, 1905.*)

Locomotive Engines. *19,229. 6th September, 1904. H. Lentz, 10, Potsdamerstrasse, Berlin, Germany, and C. Bellens, 64, Rue de St. Petersbourg, Paris.*

This invention relates to the application of cylindrical valve distributing gear to locomotives for the purpose of efficiently utilising super-heated steam. In converting an engine with slide valve distribution the ordinary cylinder is replaced by a cylinder *a* with cylindrical valve distribution, and the distributing valves are actuated by the slide *b* of the eccentric rod, which slide is maintained in its original position and converted into a distributing



valve gear rod. To this end the rod is provided with flexible joints *c*, arranged in such a manner that the external parts of the distributing mechanism may be maintained intact, or nearly so. In order to avoid the irregular expansion of the cylinder walls there is arranged upon the cylinder *a* or compound cylinder *i j* a valve chest *d*. The part which receives the live steam is isolated from the cylinder walls by chambers *f*. The cylinder walls are also carefully isolated from all conduits or pipes through which the steam circulates, particularly the supply pipe *g* and exhaust pipe *h*. (*Accepted 6th September, 1905.*)

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19890. Electric system of railway signalling. British Thomson-Houston Co., Ltd. (General Electric Co.)
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21144. Electric lighting of trains. Leitner and Lucas.
21973. Automatic vacuum brakes. Churchward.
22066. Dust extracting apparatus for cleaning railway carriage cushions, carpets and the like. Ford.
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25618. Steam heating systems for railway trains. Gold.
26358. Permanent way for railways, tramways and the like. Schlussel.

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4529. Control of the electric motors on electric railway cars. Lydall.
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7141. Weighing apparatus for railway vehicles. Zeidler.
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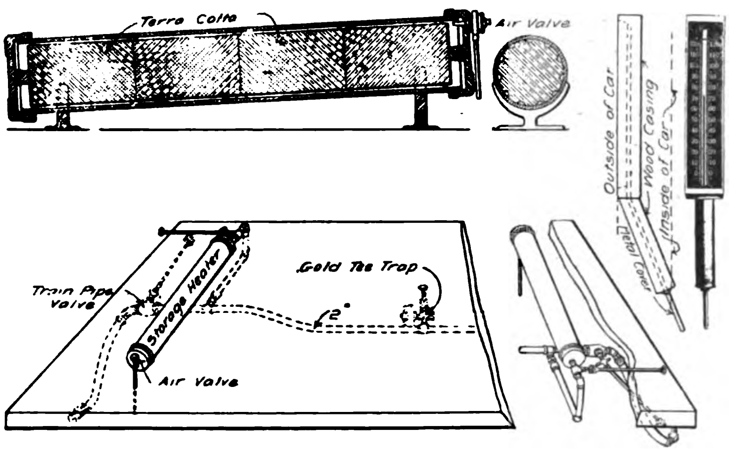
10769. Railway signalling systems. Saurman.
12788. Railway crossing gates. Craig.
12944. Means for controlling the movements of vehicles on railways and the like. Kinsman.
13761. Rail joints. Walsh.
15752. Self-releasing brake handles for electric tramcars and other vehicles. Belmondo.
16978. Tramway guard arrangement. Sperber.

Warming Cars for Perishable Goods.

TRAFFIC in perishable freight, consisting largely of fresh fruit and vegetables, has increased greatly during the winter months within the last few years, and with it the liability of damage by freezing. To prevent this, unless some means of heating cars is provided, railways are put to great expense and inconvenience in housing carloads of perishable freight during extremely cold weather. Large numbers of refrigerator cars are available during the winter for this class of traffic, if some means of heating which is not too complicated, cumbersome or expensive can be provided.

The Gold Car Heating and Lighting Company for several years have been experimenting with a storage heating system for use in exactly this kind of service. The Chicago Burlington and Quincy R., being greatly interested in the development of a satisfactory storage heating system, have, under the direct supervision of Mr. T. H. Garland, superintendent of refrigeration, carried out several tests of this apparatus, which now consists essentially of a small iron drum within which are placed cylindrical terra cotta blocks. These blocks are made in several sections and are provided with corrugations upon the outer surface to allow steam and hot water to pass from end to end of the drum, which is supported upon iron stands and inclined slightly as shown. Each cylinder is 8in. diam. by 6ft. long, and the method now followed consists in installing two cylinders per car, one in the drip pan beneath the ice box at each end. The drain trap for relieving the system of surplus condensation is placed in the pipe line beneath the car at the centre. At the higher end of each drum is placed an automatic valce which allows the air to escape. The bricks absorb the heat from the water of condensation, thereby storing heat at the same time that the car is being heated by direct radiation from the steam.

A large number of service tests have been made, and as an average it may be stated that it is the practice to warm up the cars while they are loading to about 50°, and after the doors are closed the temperature is raised to above 60°, the maximum temperature being placed at 69°. At some of the freight houses on the road steam connections are provided for this purpose, and at other places switching engines have steam heating fittings and are attached to the cars for this purpose. The time for heating a cold car is stated to be about two hours, and when they are in motion in the train after being cut off from the steam supply the temperature drops about 2° per hour until it reaches 40°, after which the loss is about 1° per hour. If the doors be open frequently it is difficult to maintain the desired temperature, and to



Gold Heating & Lighting Company's Heating Apparatus for Refrigerator Cars.

reduce the necessity for opening the door for the purpose of reading the thermometer the Gold Car Heating and Lighting Co. have designed a special thermometer, the face of which is enclosed in a wooden case set flush and open upon the outside of the car, while the tube is bent so that the encased mercury bulb projects inside the car. When the cars are in transit in extremely cold weather it is advisable to supply a little steam occasionally, and connection therefor is made with the locomotive. If the cars are warm when they reach a station only 30 to 40 minutes are required to heat them to the maximum temperature required when they are to stand cut off from the heat supply for a considerable time.

The C. Burlington and Q.R., after two years' experience with 25 cars equipped with this heater, are having it applied to 100 new cars now under construction at the Chicago shops of the American Car and Foundry Company. The experience during the two years has shown that in zero weather the heater will maintain a proper temperature for about 24 hours after being detached from the supply with the car standing. Considering the great number of refrigerator cars owned by the railroads it is apparent that the opportunity for obtaining additional service in the perishable freight traffic during the winter months is very great, especially as this business seems to be rapidly increasing; but in order to deliver this freight in good condition it is necessary to heat the cars in some way as above indicated.—*The Railway Age*

Official Reports on Recent Accidents.

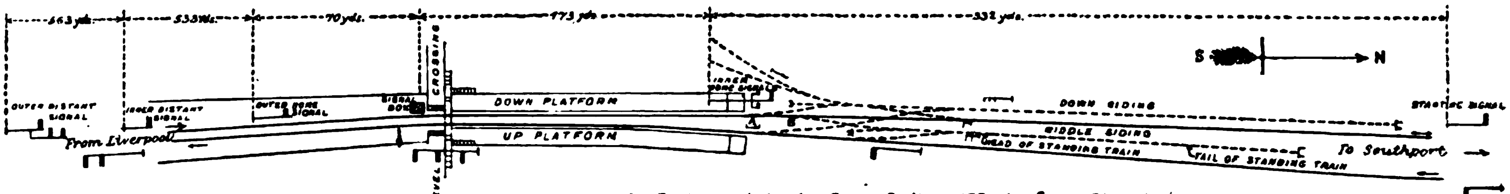
At **Hall Road Station, L. & Y.R.** *On 27th July.* *Lt.-Col. E. Druitt, R.E., reports that*:—

The 6.30 p.m. express train from Liverpool to Southport ran into an empty passenger train standing in the middle siding at Hall Road Station.

Both trains were fitted for electric traction, and each consisted of a 3rd motor car at each end with two 1st and one 3rd class trailers between them, all fitted with Westinghouse auto-couplers. The motor cars seat 69, the 1st class cars 66, and the 3rd class cars 80 passengers—a total of 350 for each train. One motorman and one guard accompany each express train. There were about 56 third-class and 20 first-class passengers in the express. 20 passengers were killed, and two* besides the motorman severely injured (all in the leading car); 45 other passengers complained of injuries.

The leading car of the express and the first car of the standing train were telescoped one inside the other. The two bogies of the first standing car were driven back underneath the second standing car, so that there were four bogies under this car. The only wheels derailed were the leading pair of the front bogie of the express. The standing train was driven back a distance of about 50 yards.

The weight of the motor cars is about 46 tons each, and of the trailer cars 26 tons each, so that the total weight of each train empty was 170 tons. The length of each train over buffers is 310ft. 2ins. Both trains were fitted with the automatic vacuum brake, working blocks all wheels, and the



A: Facing points to Down Siding 175yds from Signal box
B. " " " Middle " 200 " " " "

brakes on the express were stated to be in good order.

The site of the accident is shown on the diagram. In the middle siding the points of the connection leading to the up line are 78 yards beyond the facing-points in the down line leading into it, and the first car of the standing train was 6 yards beyond the outlet signals, which are 4 yards beyond the points, which makes a total of 88 yards from the facing-points of the middle siding and 115 yards from the inner home signals to the standing train.

The inner home signal, situated 2 yards before reaching the facing-points of the down sidings and 27 yards before reaching the facing-points of the middle siding, consists of three arms, the centre a full-sized arm and higher than the others for the main line, and smaller arms on shorter posts to the right and left of the main signal refer to the middle and down sidings respectively.

The outer home signal is visible for a very long distance; there is a perfect view of the inner home signals for 270 yards before reaching them, but before that the view is partially interrupted by the latticework sides of the foot overbridge at the south end of the station for 250 yards, but they are clearly visible beyond that again for a distance of 10 yards.

There is a clear view of the starting signal as soon as the station is reached.

The gradient falls slightly towards Hall Road, but at the station is practically level.

*One since dead.—Ed. *R.E.*

The facing-points for the middle siding and for the down siding are fitted with mechanical detectors, and in addition there is an electric lock on the lever working this signal, and which can only be released when both switch blocks of each of the above facing-points are in the most accurate adjustment, and an electric current can pass between each of the blades of both points and so back to the lock on the lever.

There is the mechanical locking of the levers, by which it is impossible to lower the inner home signal for the main line when the road is set for either of the sidings.

Neither of the down distant signals can be pulled off unless all the down main line signals in advance relating to this signal-box are first pulled off.

Supply of Electrical Current. — The three-phase alternating current at 7,500 volts is transmitted to sub-stations, where it is stepped down by static transformers, and ultimately turned into direct current through rotary converters at 650 volts pressure, the maximum voltage on the trains being about 600.

The power house is situated at Formby, and the four sub-stations are at Sandhills, Seaforth, Formby, and Birkdale. The line is subdivided at these sub-stations, and in case of a heavy short circuit current is automatically cut off the live rail by circuit breakers at one or other of these sub-stations. The line is also divided at various other points between these sub-stations by section cut-out boxes, which contain switches to be operated by hand when the line is dead; these are put in to facilitate such conditions as single line working, so that current can be kept on, say, the "up" road while the "down" line might be cut out for repairs, etc. At Hall Road current is fed from Formby and Seaforth sub-stations only. From the sub-stations the current is supplied to the trains by means of an insulated third rail, which is situated generally in the 6ft. way, the centre line of this rail being exactly 3ft. 11½ins. from the centre line of the track, and the top of the rail being 3ins. above the surface of the running track rails. The current is returned from the trains through the track rails into a partially insulated fourth rail, to which the track rails individually are cross-bonded. The trains consist of 3, 4, or 5 coaches, all 60ft. in length and 10ft. in width; the end vehicles are third-class motors. Each motor car has two motor bogies, each motor bogie carrying two 150h.-p. motors. The current is collected from the third rail by a cast steel slipper attached to a beam on each side of the motor bogies. The train control equipment may be termed the direct multiple control system in distinction to the multiple unit. The motorman operates the controller in the motor compartment at the front end of the train, which supplies current to the whole of the eight motors on a train, the different notches in this controller regulating the amount of current supplied to the motors, similar to an ordinary tramway controller. In this compartment there are also two circuit breakers, one through which the current for the front motor car passes, and one through which the current for the rear motor car passes. In case of an exceptional amount of current being taken by the

motors, or through any short circuit occurring on the train apparatus, one or both of these circuit breakers would automatically come out and cut off the supply; the motorman also is able to trip these circuit breakers, if desired, and automatically cut off the current without actuating his controller.

The following rules apply :—

73. (a) When a home, starting, or advanced starting signal, or siding signal applicable to a siding not protected by safety points, becomes defective, or is not working efficiently, a competent person must be placed at such signal with hand signals and detonators, and act under the instructions of the signalman. The distant signals applicable to the lines affected must be kept at danger by being disconnecetd from the levers by which they are worked, and must remain in that position until the defect has been made good, and all is again in working order. If the defective signal can be placed at danger, it must be kept at danger until again in working order.

(c) The hand-signalman must ascertain from the signalman in charge of the signal-box what train he is to bring forward, and, if the train which is to be brought forward is approaching facing points, he must, before signalling it forward, inform the signalman in charge of the signal-box the position of such points, and satisfy himself that they are set and secured in position for the line on which the signalman in the signal-box intends the train should run.

The authorised hand signal is as follows, viz. :—

12. To give an all right signal to engine-driver when fixed signal is disconnected or out of order—Rule 73. Green light or flag held steadily by hand-signalman at the signal.

The causes of this most unfortunate collision are clearly shown by the evidence of signalman Boote (Hall Road signal-box) and motorman Rimmer, the driver of the express train.

The statements of the two men as regards the position of the signals are contradictory, but that of Boote is evidently correct, while as to Rimmer's it must be remembered that he received a severe injury to his head and was insensible for five days after the collision occurred, and thus his recollection of the position of signals seen only a few seconds before the collision is probably imperfect.

There is a 10 minutes service of trains from Liverpool to Hall Road and a 20 minutes service beyond Hall Road to Southport. Thus, approximately, half the trains arriving at Hall Road are turnback trains, and these, as soon as the station work is completed, are run direct through facing-points either into the middle siding or into the down siding. From these sidings the empty trains can be brought out direct to the up platform ready for the return journey to Liverpool.

The train leaving Liverpool at 6.20 p.m. arrived at Hall Road at 6.39 p.m. and was sent into the middle siding at 6.40 p.m.

Boote was offered and accepted the 6.30 p.m. express train Liverpool to Southport from the Crosby signal-box at 6.41 p.m.

When he had put the 6.20 p.m. into the middle siding he reversed the facing points leading to it, so that they were in the normal position, *i.e.*, right for the main down line, and bolted them. As soon as he accepted the 6.30 p.m. express he lowered his outer home signal, which requires the bolt locks of both the facing points to be home, and also the starting signal, but when he tried to lower his inner home signal he was unable to do so.

Thinking the switch blades of the facing points leading to the middle siding were perhaps not absolutely in their true position, and that in consequence the inner home signal was being held at danger by the electrical detector, he placed his starting signal and outer home signal to danger, put back the levers working the locks and locking bars of both facing points and worked the facing points leading to the middle siding, three times more vigorously, intending to force the blades into their accurately true position.*

Boote finished up by pulling over the lever working these points, by which means they were set for the siding instead of for the main line. He then pulled over the levers working the locks and locking bars of both the facing points, and lowered his outer home and starting signals. Finding he still could not lower the inner home signal he went to the window of the signal-box with a green flag and waved it to Rimmer, the driver of the express, intending thereby to signal the train past the inner signal at danger, which was 173 yards in advance of the signal-box.

Rimmer accepted this unauthorised signal. He was at the time running slowly as he was approaching the outer home signal at danger, but turning on the full current he rapidly accelerated the speed of the train and was running from 40 to 50 miles an hour before he saw, when too late, that the facing points lay for the siding and not for the main line. From the points to the standing train was a distance of 88 yards, and, judging by the terrible result of the collision, speed could not have been appreciably diminished before it occurred.

Rimmer's statement is to the effect that the signals approaching Hall Road were in the following positions, viz., outer distant at danger, inner distant lowered to safety position when he was approaching it, outer home at danger; accordingly he was preparing to stop at it, and had slowed down to about 15 miles an hour, when he saw Boote lean out of the signal-box and wave a green flag, which he understood was to bring him past the outer home signal, which he states was at danger. Rimmer also declares that Boote shouted out "Right away" as he was passing the signal-box, and so he turned on the full current and rapidly gained speed. Rimmer also declares that the inner home signal was lowered to the safety position all the time he saw it until a few yards away from it, that then it was thrown to danger in his face, that just then he noticed the facing points were set to lead to the middle siding, and that he cut off the current by moving the controller handle round to the "off" position and applied the vacuum brakes hard on, and that they took effect just before the collision occurred.

It is impossible for the inner distant signal to be pulled off into the all right position unless the three signals ahead of it, viz., the outer and inner home signals and the starting signal, are also in the all right position, and the inner home signal could not be lowered as that was the cause of Boote's mistake. If for inner distant we substitute outer home, and for outer home inner home, then his statement agrees with Boote's, but in any event he either did not notice the inner home signal at danger, or else took Boote's signal and so ran past it at full speed without any authorised permission to do so.

I also doubt very much if Rimmer cut off the current as he states, as the handle of the controller was found in the full "on" position. It is locked by a catch in each of its six or seven positions, and could not be turned a full circle by a succession of blows without being broken. What Rimmer probably did was to put on the vacuum brake as hard as possible when he found his train had entered the middle siding, and this has the effect of causing the circuit breakers to come out, and the sharp cracks caused by this were heard by Brereton, the motorman of the train standing in the down siding.

* These facing points being at the full limit of 200 yards from the signal-box would require a very smart movement of the lever working them to get them truly home and so to make the electrical connection for the detector to work, owing to the friction of the long length of rodding on the rollers of the supports.

Also Boote denies that he shouted "Right away" as Rimmer passed him.

Boote no doubt made the initial mistake. He says that when the express was approaching the outer home signal and he could not get the inner home "off," the thought flashed in his mind that he would be fined if he stopped the express. He had never been fined himself for this reason, but had heard that another signalman had been, but he did not know why, beyond that he had stopped an express either through irregular working or some other cause. This thought, and also because he jumped to the conclusion that it was the electric lock on the inner home signal that was preventing it from coming "off," apparently induced him to neglect the rule he knew should be carried out, and so he sent on the express without first having a man sent to the signal to give a proper hand signal after first seeing that the facing points were in the right position. Had he done so the express would have been delayed a few minutes, but no collision would have occurred.

Rimmer should have stopped at the signal-box and ascertained what Boote meant by the green flag.

Boote says he had no trouble on his mind and no reason for making the mistake. When the 10 minutes service of trains was first started 18 months ago he says he found the work hard but not too much for him. Six months ago Boote states the three signalmen at Hall Road sent in a written application to the stationmaster for the assistance of a booking boy, but the stationmaster states that neither of the men ever made any application to him either written or verbal, and no mention of any assistance being needed was ever made to the district inspector, who constantly visits the signal-box. The duties are no doubt continuous, but are simple and straightforward. The tour of duty is 8 hours with 16 hours' interval. The gates have to be worked on an average less than once in every hour. These duties are not excessive, and, as Boote admits, they had nothing to do in any way with his action which caused the collision. He had been on duty just 6 hours when the collision occurred.

Thus the collision was due solely to inadvertence in leaving the siding points in the wrong position and then to disregard of rules on the part of Boote, and to disregard of rules and reckless driving on the part of Rimmer.

The only lesson to be learnt from this calamity is the very old one, viz., of the necessity at all times of complying exactly with all rules and regulations, and that punctuality and fast running must always give way to safety requirements.

This collision naturally attracted much attention owing to the great number of deaths resulting from it, and also owing to its occurring in a section of the railway worked by electric traction.

It may be desirable, therefore, to refer to some of the many points raised in connection with the occurrence in the Press and elsewhere.

1. The alleged greater danger of facing points as compared with trailing points on a line on which express trains run.

This danger does not exist with the safeguards especially introduced, and which have been described above, to prevent a signal being lowered to the safety position unless the points are first accurately in position for the line to which the signal refers. Given the conditions of traffic at Hall Road Station, the facing connections are in my opinion the simplest and quickest way of getting the turnback trains off the down road clear of following trains, and therefore the safest.

2. Whether the open corridor type of car used on this railway fitted for electric traction is more liable to be telescoped, should a collision occur, than the ordinary pattern with separate compartments?

These open cars have very strong and heavy underframes, and the tops are light and independent of the frame, being secured to it by a few bolts.

It may be pointed out that the open corridor carriage is coming into use on many railways where steam locomotives are used, and judging by the damage to the cars forming the express train behind the first motor car, which was very slight indeed, there would appear to be no extra danger with this type of car.

3. With regard to the danger from fire, it may be pointed out that on this occasion as soon as the collision occurred a short circuit was set up between the live rail and running rail, probably through a bar falling across them, and so a very large arc was formed at once, and this blew the section circuit breakers at the Formby sub-station but not those at the Seaforth sub-station, which were much further away from Hall Road, but the sub-station attendant at Seaforth records a heavy overload at the moment of the collision. This arcing caused by the short circuit soon ceased, either from the bar being fuzed through or something being moved, and then the current fed to the third rail from Seaforth was normal, showing that no short circuit existed. When the circuit breakers at Formby sub-station blew, the switchman on duty there telephoned to Seaforth sub-station and also to Formby signal-box to know if anything was wrong, and being informed all was well there, he, thinking the circuit breakers had blown through overload, restored them, and found there was a load of 600 ampères (less than the normal load), and this shows that there was no longer a short circuit and therefore no arcing taking place. As soon as he had restored the circuit breakers the Hall Road stationmaster rang him up to cut off the current, which was done at once both at Formby and Seaforth sub-stations, and the third rail rendered dead for that section of the line. About 4 minutes had then elapsed since the collision had occurred. On subsequent examination it was found that there were no signs of fire on any of the cars, except a slight charring of the woodwork underneath the first car of the standing train, and signs of short circuiting between the broken conductors and the ironwork under the car, which caused a certain amount of smoke, but there was no actual fire in any of the carriages, and no one in them could have received any electric shock. It may be mentioned that iron bars are supplied to stationmasters, and are also carried on the trains, for setting up a short circuit and thereby blowing out the circuit breakers at the sub-stations in case of emergency. On the occasion in question the stationmaster should have telephoned at once to have the current cut off, as he saw the large flame of the arc, instead of first going to the scene of the collision. It may be remembered that in a bad end-on collision last winter the derailed coaches of an express train, driven by steam, caught fire, and several were totally destroyed. So far as can be gathered from the results of the first bad collision on a railway worked by electric traction in this country, there would appear to be no extra danger of fire occurring among derailed coaches than on a railway worked by steam.

4. It may also be mentioned that though there is only one motorman on each electric train, the guards are instructed as to how to stop a train in case of emergency should the motorman be suddenly incapacitated. On electric express trains there is one guard, with instructions as soon as the train starts to walk through the train from end to end, count the passengers, and then stand behind the motorman for the remainder of the journey. On electric stopping trains there are two guards, one of whom is always standing behind the motorman when the train is running.

Looking at the facts connected with the collision, the two most striking results are, first, the absence of any fire among the derailed coaches, the danger from fire being one regarded as especially liable to occur on railways using electric traction; and, secondly, the very small amount of damage done to the cars, with the exception of the leading one of each train, due no doubt to the very heavy and stiff underframes.

Probably the collision would not have been so severe if steam locomotives had been in use, as under the same conditions the acceleration of the express would not have been so rapid; that on the electric trains is stated to be such that a speed of 30 miles an hour can be obtained from rest in a period of 30 seconds, but this, and the quick stopping due to the very powerful brakes in use, form the great advantages of electric traction for a fast and frequent passenger service of trains, and no danger need result therefrom if the ordinary rules for working trains are adhered to.